School Science
and
Mathematics

THE GREAT WATER BEETLE—A SUGGESTION FOR AQUARIUM STUDY.

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On the evening of June 18, near an electric light on Calvert and Centre Streets, in the city of Baltimore, I picked up a large black object crawling on the pavement and saw it was one of the big water beetles strayed from country into town and probably dazed by strong light and so upset in its flight.

These beetles make very remarkable migrations, remarkable in that they abandon the ponds in which they have always lived and which are good places for their young, just as the breeding season comes on and they are ready to lay eggs; but instead of laying eggs at home they give up their aquatic life and for the first time come out of the water and use their wings which have been packed away and unused so far. They then fly away for considerable distances and many no doubt die and fail to find suitable ponds in which to lay eggs. Others may find ponds good for such beetles to live in.

This sort of migration habit would evidently tend in time to scatter the beetles all over the accessible regions containing possible ponds, though of course the departure of so many from ponds in which they have been living would make these ponds less populous. Whether ponds get overstocked or not and whether the beetles migrate every breeding season or whether, like the Norway lemming, they migrate only at intervals are facts to be found out by future observers. We also know nothing as to what starts the beetles to fly away—whether every adult must fly away to satisfy an instinct or whether something about the character of the food, or water, or presence of other beetles may lead the beetles to fly at certain times.

There is here room for much good work in observation. Comparative study of insects leads one to suppose that these water beetles used to be land beetles which later came to live more and more in the water but returning to the land always to procreate their kind. The process of reproduction did not get arranged for water life as soon as did the feeding habits. Finally all the life was adjusted to water life excepting only the nuptial flight, which as in so many insects involves wide migrations and meetings of males and females from distant points. So in the present kind of water beetle the sexes are said to meet in the brief time that the beetles are flying about outside the water and thus it might happen that males and females from distant ponds might meet and mate. The chances of cross breeding from diverse ponds is perhaps of sufficient advantage to partly compensate for the disadvantage of having so many adults lost while flying far away from their natural dwelling place. To return to the individual picked up in the street:

Putting it into a small aquarium, I was surprised the next morning, June 19, to find floating on the surface of the water a peculiar nest made of hardened froth and about as big as the end of one's finger, shaped like a round grape with a curious stalk standing up from one side, looking like parchment paper of yellowish white color but with the stalk brown. In this spheriodal mass was a thick plate of very large long yellow eggs as was seen by slightly cutting into the case. The nest was made of an outer parchment-like cover which later turned brownish and within which was a horizontal plate of eggs all set side by side and standing vertically. Between the egg mass and the outer case was a spongy mass or clear soap-sud-like collection of froth. The air contained in the bubbles of this froth made the whole nest float partly out of the water with the stalk sticking up into the air.

Left thus floating for four days, I noticed at 9 a. m. June 23, minute white threads and a dark moving mass amongst the eggs. This I thought meant that some maggots from parasitic flies had got in and were eating up the eggs, but it proved that these maggots were actually the young beetles hatching out of the eggs so soon. At 9:30 these young came crawling and wriggling out of the nest in swarms, as dark blackish maggots. Some few dropped down to the bottom of the water but most all moved along on top of the water by jerks of the body. The tail end of each remained fast to the surface film of the water, and at this end were

the two slender white feelers that had led me to think there were minute white maggots when seen moving amongst the eggs. These feelers sticking out from the end which seemed more active suggested the white long curved tusks of a walrus, but were of course soft feelers from near the anus. Near the head end were six long limbs dangling down in a useless way. The head itself was large and light colored and on it were two sets of each six red ocelli or simple eyes each of elongated form. Thus in 4 x 24 hours the egg which was about 3mm. long had left the mother and hatched into a larve some 4-5mm. long. These active young soon began to swell up and to grow larger by taking in air, water, or both, I suppose, and in 12 hours after hatching were 10-12 mm. long. That is, they swelled up to be 2 or 3 times their length without taking food.

The next day, June 24 at 9 a. m., the young, 24 hours out of the egg, were 15 mm. long and very active, all the time swimming rapidly through the water by quick flapping of their weak legs. The back part or abdomen was full of air and the animal frequently floated and swam up to the surface of the water and there seemed to breathe through the anal end of the body. From the head end there now stuck out a long slender pair of forceps, jaws or tools, like a pair of ice tongs, and two longer feelers with black and white segments. Along the sides of the body were hairs and the long legs flattened and fringed by long hairs were good swimming organs, like oars, but had hairs on the basal parts only, not on end parts. These little beasts seized small tadpoles, young gold fish 1-2 inch long and earthworms and greedily ate them. They were exceedingly active, cursed with excessive strenuousity, never at rest, always exploding energy, but ever recovering and gaining force by enormous feeding. Ravenous, insatiable, disgusting, cruel—the epitome of that evil in nature which seems embodied in carnivora that destroy the most beautiful of animal life or of that greed for killing that leads certain fish to tear and dismember whole school of their peaceful comrades in ocean life.

Put upon a sheet of glass these little "water tigers" crawled like maggots and added to their repulsiveness. They had the habit of holding the head up and of moving it freely about even laying it far back over the shoulders. By June 27 the larvae measured 16 mm. when dead and had eaten many earthworms given to them in pieces or whole. They seized the big worms with their mouth parts and wriggling the body and lashing the

tail end worried the worm as a dog might a bull; not tearing off flesh but somehow sucking out from the earthworms its content and leaving little but an old skin and some earth.

By July 2, less than two weeks from hatching, all the larvae were gone except two, but these two were of great size and apparently contained not only the digest of many earthworms but resultant of all the other larvae as well. For whenever a larva was inactive, or embarrassed in casting its skin, or sick, it would be attacked by others and though ordinarily when one came near another the two would pass by without attacking, yet the sick or dead were consumed by the others till only two remained alive. This recalled the ballad of the "Nancy Bell":

"Oh! I am a cook and a captain bold,
And the mate of the Nancy brig,
And a bo' sun tight and a midshipmite,
And the crew of the captain's gig."

These two had cast their skins several times, each time being less active till well out of their old skins; at first white, but soon turning darker. The two big survivors swam about by kicking their legs and also by swaying the whole body sidewise like a snake. Coming near an earthworm in the bottom of the aquarium they seemed not to know of it till touching it when they at once seized it and never let go but pulled and dragged at it with their sickle-like jaws and worried it bull-dog fashion. At times they were forced to rise to the top of the water to breathe and would then haul the big worm with them by means of their powerful swimming jerks of the body. The anal end of the body was then stuck up to the top of the water and air taken in through a hole just above the anus. Meantime the head end hanging down in the water was busy sucking in the earthworm's juices. The body of these beastly larvae seemed so full of air that they tended to float and had to hold on to water plants to keep themselves down or else to swim downwards all the time.

The following day, July 3, the question as to which one should survive was decided, not as in the ballad by one cooking the cook, but by one dying. The dead one preserved in a bottle was 45 mm. long, 10 wide and 4 thick. Its head was 4 mm. wide and 2 deep. The jaws were 4 mm. long. It had grown to this size from an egg 3 mm. long laid just two weeks before. The sole surviving larva now became less active though still a repulsive worm—*a bag of gluttinous carnal machinery!*

It celebrated July 4th by shedding its skin again, casting off

not only the outer skin but the inner skin; that is, the lining of its digestive organs and moreover the lining of its large branched air tubes. In this case the shedding was not neatly done and for a long time the beast swam about with a long piece of loose gut-lining hanging out.

By July 16 the creature had become sluggish and moved about but little. Though it still ate a small piece of earthworm it did so with little avidity and seemed at length satiated. Its size was now 50 mm. or 2 inches long, 10 mm. wide and 7 mm. deep; thus from the egg it had grown upon air, water, earthworm and its brothers and sisters to be of this great size in a little less than a month; that is, at a rate of 2 feet a year!

The human embryo may grow at the above rate for nine months, but after birth that rate would bring the man of twenty to a height of nearly 42 feet.

July 18: Put larva into dish of water with pile of earth at one end and July 19 the larva disappeared and, as the dish was tight, most have *gone into earth*.

July 23: Dug into earth and found a rounded cavity 3 mm. in diameter and in this a *pupa*. That is, the larva had left the water and gone into *wet* earth and then hollowed out a house or rounded cell more than 1 inch wide, completely closed in on all sides. The walls of this house were nicely *smoothed and packed*. The larva had transformed into a different looking thing—a pupa —exactly one month after leaving the egg.

This pupa was a large, white object looking as much like a beetle as like a larva, or in fact much more; though one would scarcely suppose it was a beetle at all except for its folded legs and antennae. It lay upon its back and had plenty of room round about it in the house. When touched it wriggled its body slightly but couldn't move from place to place, though it turned over and rolled about. It had six evident pale, soft useless legs and on its head, each side, 3 whisker-like stiff curved horns. The pupa was milk white and moist looking and the walls of its house were soppy wet. A little color was present in the eyes and in faint spots along the abdomen. The length of the pupa was 22 mm., width 15 mm., and thickness about the same, so the creature had become much shorter, though thicker, in the transformation. The larval skin from which the pupa had come out was flat against the wall of the house, crowded to one side and compressed as if by rolling about of the pupa. This skin was about 80 mm. long when stretched, while the live larva was more

than 50 mm. long. The larval skin was split along back and showed the linings of tracheae or breathing tubes.

July 28: The pupa was in the same condition and very active when disturbed.

August 2: Found the mud had fallen into nest-hole but the pupa was now a *complete beetle;* wedged into its house by fallen roof; when this was removed the beetle kicked and turned over onto its belly. The color was green black above and a rich brown below.   All clean and bright.   I put back the cover of mud to see if the beetle would escape by itself. The pupa state then had lasted only 10 days. The next day the beetle had broken out of its mud house and was swimming in the water. It was smaller than its mother, and as yet more green black and softer to the touch as its shell was not yet hardened thoroughly.

This beetle was kept in an aquarium with elodea which it ate, cutting off the growing tips and destroying much of the plant. As there were many oligochetes on the glass of the aquarium where the beetle was browsing, it may possibly have eaten them as animal food. Alone, without any chance of being in any way influenced by any other beetles in a small aquarium in a closed room: yet August 21, when 19 days old as a perfect beetle, it laid eggs in a special cocoon though having no instruction nor sexual stimulus from outside its own body. The eggs thus laid without the presence of a male could hatch only if they were to develop without fertilization as happens in some insects, but in this case, though everything seemed favorable for this development of the eggs, they did not develop and the experiment showed only that the isolated female would lay eggs without sexual intercourse and that these eggs did not develop, apparently because they had not been fertilized.

The way in which the instincts of the female resulted in a perfect floating nest for the eggs was seen in part. On the morning of August 21, the beetle was at the surface with the abdomen thrust into an incomplete egg case.   The case was fastened under a floating leaf.   By noon the egg case was completed; it now had a reddish stalk which had turned brown by the next morning and which stuck up into the air like a leaf.   The dead leaf was but slightly fastened to the egg case and easily separated in handling the case.   The case was left to float till September 3rd, some 12 days and then examined.   The eggs were real eggs but all bad and not developed.

The case was 3-4 of an inch wide and 1-2 inch deep, a flattened spheroid. The stalk rose 1-4 inch into air. It was made of translucent, hardened mucous and material like spun gelatine. The outer case was easily indented but elastic and tough. The case floated lightly with part out of the water. While the upper surface and the base of the stalk were brown the rest was clear and almost colorless. The eggs were in an inner spongy bag and a wide open space surrounded this and opened to the exterior so that in lifting the cocoon out of the water air entered into the space, but the space was partly filled by some spun material that made walls or lines in it. The orifice was below the stalk and 3-8x2-8 inch in diameter. At the orifice the inner case was suddenly contracted upward to be the stalk. Apparently the outer case was made first and then the inner case full of eggs, and finally the beetle withdrawing its abdomen glued both inner and outer cases together by a mass which formed the stalk. Probably when released the cocoon floated up away from the weight of the beetle and possibly the stalk was made by the glue of the beetle being mechanically pulled out by the buoyancy of the case till it finally broke away from the beetle and stuck up into the air.

After laying eggs the female beetle continued to live in an aquarium during September, October, November and December, and was still alive in January. It swam about but little in the cold weather and when the thermometer fell to freezing in the aquarium the beetle remained inactive near the top of the water holding to water plants. It had no chance to crawl out of the water so that it is not evident if it could bury in the mud on the shore and it had no mud at the bottom of the aquarium to bury in.

In phenomenal weather, January 8 with the thermometer at 70 for several days so that the icy bathroom containing the beetle aquarium thawed out, the beetle responded to the summer temperature of 74 by emitting a loud "clicking" noise like that of the smaller Dytiscus, audible twelve feet away at 4:30 a. m. and at 8 a. m. in gas lighted room. Possibly, however, this loud note may have been made by a Dytiscus in another aquarium of chara in the same room.

February 18 the beetle came to the surface to breathe with the aid of the antenna of one side, but February 22 she was dead at the bottom; probably no longer able to breathe since some kerosene got onto the surface of the water and made her breathing apparatus inutile.

TABLE OF LIFE HISTORY AND SUMMARY OF DATA.

June 18—Beetle caught.

June 19—Case made and eggs laid.

June 23—Eggs hatch.

July 4—Larvae shed for last time.

July 19—Left water and entered earth; was 2 inches long.

July 23—Had made a pupa house and was a pupa.

Aug. 2—Became an adult.

Aug. 21—Laid eggs.

Feb. 22—Died from accident.

Thus the beetle lived as egg in special nest 4 days.

As voracious larva—1 month.

As pupa in mud—10 days.

or only 1 1-2 months from leaving mother as egg to being adult beetle.

The adult laid eggs when 19 days old, and lived 204 days as adult beetle.

This big beetle, Hydrophilus, thus makes a most interesting aquarium study. In England where popular natural history is more developed than here and where the aquarium is the source of pleasure and instruction to many, these beetles are known as the "Harmless Water Beetle," in contrast to the smaller Dytiscus water beetles which eat up fish and tadpoles and so raise havoc in the aquarium. The big water beetle seems to eat chiefly living and dead vegetable matter and though it destroys water plants it will not eat up tadpoles and fish. In England as stated in "The Book of Aquaria" by Bateman and Bennett (a book for which we lack an American equal) the beetles may be bought from dealers in Aquaria supplies for 1 s. to 2 s. 6 d. per pair.

Natural history chronicles such as the above may, these days, easily be made by any teacher and pupils who have access to ponds and an aquarium, however simple; but time was when only few eccentric men ventured to add such facts to the accumulations in print that help form the inherited wealth of the race. Aquarium study of life histories raises many questions, some of which are readily answered by the scientific methods of observation and experiment, while others demand for their solution the resources of philosophy and religion.

Carpenter, in his recent book on insect transformations, has well said, "The changes undergone by the humblest insect may serve to introduce the observer to the great mysteries of life," p. 271.

The water beetle, Hydrophilus, has had its share of admirers who have independently followed its habits and recorded their observations. Some of this history is to be found in the excellent work of Miall, "Natural History of Aquatic Insects," London, 1903, MacMillan Co., a booklet that might well find place in the library of every teacher of natural history.

Apparently the first observations made on Hydrophilus were those of Lyonet, who is famous for his classic on the anatomy of the caterpillar that eats the willow. Living 1707-1789, educated for the ministry in the Protestant church, but changing to law, he became confidential translator and cipher secretary to the United Provinces of Holland; but in 1742 began to publish drawings on the natural history of insects. Many of his notes and 54 plates of his drawings were published long after his death, at Paris in the Memoires of the Museum 1829, 1830, 1832. In volume 18, pages 438-457 we find an excellent account of the great water beetle illustrated in Plate 23, Figures 47-50 and Plate 24, Figures 1-23.

It seems that in mid August Lyonet picked up amidst plants at the foot of a tree one large larva to which he offered insects and plants, but concluded from its size, three inches, and its refusal to eat, that it was about to transform and so he gave it earth and grass. It responded by making a hole lined by grass and there lay in a curved position for several days till September 2, when becoming smaller, it split its skin and appeared as a white pupa. But this died after some weeks, having a wound on one side.

Lyonet says that instead of concluding that the animal was terrestrial and a vegetable feeder he suspended judgment awaiting more facts. In early July he found floating in ditches a white cocoon the size of the end of the finger, flattened with a "mast" at one end. It contained about 50 eggs which were translucent and let the young be seen moving, about a day before they hatched. They got out of the case by making an oval opening in lower part of the flat end of the cocoon. They swelled up three times the size of egg before taking food.

July 8, he put 30 mouse-colored young by themselves and fed them with small water snails. The larva seized the snail with its jaws and throwing back its head rested the snail on the back of the larva, as upon a table. It then held the snail with its legs and devoured it.

The larvae also ate pieces of large snails and of tadpoles, and ate

one another when hungry; but they would eat a tadpole together and crowded side by side seemed to take pleasure in companionship. They came often to the top of the water to breathe through the tail end and they cast off their skins three times, remaining inactive before and after each moult and taking no food when making their new skins and when getting their muscles fastened to their new skins. As the head was white at first the eyes were evident, but when the head turned dark the eyes were not easily seen.

Lyonet tried to get larvae to change into a pupa state. One left the water and crawled about his room, July 1st and several others died when put into a dish with earth. Yet others made holes and changed about from one place to another. Finally. August 24th, one had changed to a white pupa inside its house, Lyonet finally gave a larva that had wandered over earth 15 days, wet earth in a lead box and it made a good pupa. The absence of enough moisture explained why so many larvae did not transform. The pupa had stiff bristles or hooks on head and tail end and Lyonet sought to discover what might be the use of these organs in a creature that would live but a few days inside a hole in the ground. By means of the hooks the pupa can lie on its back, supported as upon a tripod, moist, but not wet, and with its delicate skin free from the pressure of the weight of the body and contact with wet earth. The pupa has air holes, spiracles, along the side of the body and not at the tail end as in the larva.

Lyonet's attitude towards the meaning of natural history facts seems indicated in his pleasure at discovery of the use of the apparently useless hooks on the pupa. He says, page 451: "Ainsi, vous voyez que cel filet écailleux, si inutiles en apparence a l' insecte, lui sont tres-necessaires; et que de vouloir decider, comme vous faites, que telle on telle chose est superflue dans la nature, parce que nous n'en aurions deviner l'utilite, est une temerite tres-ridicule a des etres aussi bornes que nous sommes."

Finally the pupa turns darker, first eyes, then jaws. It then bursts open its skin and appears as a perfect beetle. In the male the front legs have a triangular plate to hold the female.

Beetles are lighter than water and have to swim to go down. They swim by using legs alternating on opposite sides which is not well for speed. The front pair seemed chiefly for steering.

Lyonet kept two beetles till frost, but as soon as ice formed in the dish they went to the bottom and died. In a swollen up

dead male the abdomen protruded organs which Lyonet figures and describes. Lyonet sought to find out how the females made their cocoons and so he put some females into a lead tank with water plants.

On the first of June a female made a cocoon by using spinning organs at the tail end like a spider, but only when she had floating objects on the surface of the water, as duck weed, filamentous algae, or shavings, and when not disturbed by other insects. Two minute spinnerettes each formed a thread and moved parallel to the other. The beetle first lay upside down and buried its abdomen in algae and used the front pair of legs to fit algae to the side of the body. Then it weaved a flattened arch of white silk across its body; then turned over and wove a like piece to form the bottom of the cocoon. Then wove the two concave pieces together at sides and in 1 1-4 hours had the outer case complete; but she remained about two hours with her body buried in cocoon at first, and then gradually withdrawing it. When the body was all out she spun around the mouth of the case to narrow the hole she came out of. Then spun up and down to make the flat end of a mast. This mast was at first a short point and was gradually elongated into the air by abdomen sticking up into air, thus while the front part of the beetle was under the water when finishing the case, the anal end stuck up into the air. The cocoon was finished in about 5 hours. The use of the mast, Lyonet says, may be to get rid of excess of silk.

July 15 he saw an opening in this case at the foot of the mast and next day one larva came out and the following day 50 more. This finishes the life history of the beetle as described by Lyonet.

After Lyonet, in 1809, a Frenchman, Felix Miger, published an account of the metamorphosis of Hydrophilus in the Annales of the Museum, vol. 14, pp. 445-459, with a large plate, which account was thus published though not written long before Lyonet's full account was published, but Lyonet had previously published his account of the making of the cocoon of Hydrophilus in 1745, in Lessers Theologie des insects, vol. 1.

In the first days of May, 1807, Miger found Hydrophilus near Paris, and found that they ate plants, and also dead larvae and snails. He saw that the males rode about on the females, holding by peculiar plates on the first legs, and then a few days after this the females laid eggs. Miger saw three females make their cocoons, but only one in its first stages, since at first they are easily disturbed, but when egg-laying began the process con-

tinued in spite of all interruption, in fact, when taken out of the water and put on a table the female continued to lay and spin. The top of the case was then cut off with scissors and for 1-4 hour all the mechanism of spinning was seen within the cocoon.

Floating objects seem necessary to start these laying activities, since three females in a dish with no floating object did not spin or lay, though they did each deposit a sort of case of secreted matter about as big as a grain of barley, but with no eggs nor liquid inside. The female in laying turns upside down and with its legs holds a leaf so as to buckle it while spinning under it a case around her abdomen. The spinning organs on the slender tubes projecting from the anal end of the female are quickly thrust in front and moved about while pouring out a white gummy liquid that is drawn out into threads. After 10 minutes the female turned over and still keeping the abdomen inside the spun cap kept on for 1 1-2 hours till the case around the abdomen was so thick the spinning could no longer be seen through it. The telescope-like spinnerettes are hard and not of themselves mobile but the base to which they are attached moves and directs them in all movements they make. When the capsule is so far made, air is seen to issue from it and this is air from the body of the beetle which has gone in and filled the case and is now being forced out again by the eggs coming from the oviduct into the case. As the eggs were laid they were placed side by side and were covered over by the spinning of a white and transparent liquid. In 3-4 of an hour the laying was done and the insect drew out its abdomen from the case and took up a new position. The female now spun the "mast" or stalk. Standing head down in water and holding to a leaf by its hind legs on each side of the case the spinnerettes were visible slowly making the mast from the base upward for 1-2 inch; this took more than 1-2 hour, making the whole cocoon cost about three hours work. The stalk was made in successive layers, each smaller, so that the stalk is conical. The material was a yellowish thread that instantly hardened. The cocoon is made of three secretions. (1) The first sticky liquid part that adheres to everything and coagulates and makes a firm outer membrane that would not let in the air. (2) The material made at the time of laying and which envelops each egg in a cotton-like mass. (3) The material of the stalk, like silk, dry, porous like the cocoon threads of lepidoptera.

The cocoon is thus formed over the body of the insect and hence has its flattened spheroidal form. The hole left when the

body is drawn out of the cocoon is closed in only imperfectly by threads that keep the water out since the case is full of air, but some water may enter and the eggs near the orifice may decay.

Miger thought the porous nature of the stem that sticks up into the air allows for entrance of fresh air for the life of the eggs. Cutting off the bottom of a cocoon we see 40-50 eggs each 2 lines long, side by side in a cake. Each egg is in its own envelope of cotton-like material; all eggs stand at equal intervals in a plate, each about vertical. This cotton-like material is fastened to the top of the cocoon and an empty space is left below it. The larvae are made in the eggs head down, and when they hatch they go down to the lower part of the cocoon and move about there for some 12 hours before leaving the cocoon. The eggs develop in 12-15 days, May 6 to 29; but high temperatures make them develop more rapidly. The young that come out of the cocoon may go back and play about till hungry.

Miger gives a description of the larva and says it moults several times. But he did not succeed in rearing any from eggs to adult, but did rear some caught as larvae. In catching these larvae he found that they made themselves as flaccid as empty skins, but when seized near the tail suddenly contracted 1-3 of their length and emitted with a slight sound from the anal end a black fetid water. They swam readily, breathed through the tail end at the surface of the water, and held to plants and often to one another. They did not fight one another but devoured snails and bits of cooked meat on which they lived 15 days. He says he often repeated Lyonet's observations and assured himself of their truthfulness. Finally the larvae refused to eat and thrust out the tail end from water as if wishing to transform. When put on earth they dug holes 2 inches deep with their jaws and legs. It took them 5 days to make a house with walls everywhere flattened down by their bodies. The house was a spheroidal hole 1 1-2 inches in diameter without any opening and very smooth on its lower part. The larva lay for 6 days and then transformed. Its back split open to the 4th ring and the pupa emerged 30-40 lines long. The pupa rested upon 2 sets of each 3 hooks and also on a few spines at tail end, thus not in contact with earth.

Miger says the curvature of the hooks is such that when the pupa is turned over it gets back again at once by movements of its wings, but in a cavity of different curvature it can turn over only with difficulty. The pupa lived 3 weeks and its white

color gradually turned dark as it became a perfect beetle covered
by a white envelope which split along the back. The creature
turned over and with legs and movements of the body removed
the envelope. The wing covers, which were on the side, now
came onto the back. The wings were expanded and held so till
they were hard. Soon the insect put its wings under its still
white and soft wing covers and stood up on its weak legs. In 24
hours it turned brown and then remained 12 days in the ground
without movement and then with hardened legs and jaws made a
small hole in the wall and escaped with compression of its still
soft body and wing cases. Thus the life cycle was complete in
about 98 days of which 60 were in the larva state.

The accounts of Hydrophilus given by Lyonet and by Miger
have been, in part, translated by Miall who has added the fol-
lowing from A. G. Laker 1881, concerning the cocoon; as well as
many facts of his own observation; so that Miall's account is the
best single statement up to the present time.

According to Miall, Laker found the cocoons to average 11 1-2
to 10 3-4 lines in diameter with a stem of about 17 lines. They
float with 1-3 of depth out of the water; usually but not always
attached to long grass or to floating leaves. The spike is stronger
than the rest of the cocoon and is hollow except for a dark
thread-like substance crossing and recrossing it, thus like a horn
stuffed with tow; but the apex is closed. When the spike was
cut off from two cocoons the eggs did not hatch, though there
was no apparent difference between these and other cocoons
that hatched eggs. Subsequently these cocoons with spikes cut
off sank.

While it does not seem to Laker that the spike is a balance to
the cocoon; yet if the cocoon is put with spike parallel to the
water the cocoon rights itself and the spike goes up into the air;
but if the spike is put partly under water the cocoon turns bottom
up. He found the eggs to be usually 50-60.

In the life of this big beetle a very interesting arrangement
for breathing was described by Nitsch in 1811 and confirmed
by Miall. As in so many creatures of small size that live under
water, yet need to come to the air to get oxygen, the film of water
at the surface acts like a membrane, as a resistance to be over-
come, somewhat as in the case of a man living under water and
finding a rubber cloth stretched over its surface every time he
came up to get air; it is necessary to break this "tension film"
and also to keep the water out of one's breathing holes and
receptacles.

Hydrophilus has hairs over the under side and also under the wings and thus carries a load of air which is breathed in through spiracle on the sides of thorax and abdomen. In some beetles in water the chief breathing holes are at the posterior end of the abdomen, and these beetles come up tail first to take in the air. Hydrophilus takes in air through anterior holes and it is remarkable to see the heavy, clumsy beetle swim every now and then to the top of the water and then lie along beneath as if dead and with no evident means of getting through the surface film to get air. Nitsch, however, found that there is a special mechanism to take in air forward and the animal turns so that air is taken in on one side back of its head. While Dytiscus takes in air at tail end under its wings, Hydrophilus pumps air under its wings from the reservoir over the ventral surface and does not put tail end to the surface. Nitsch couldn't find out how the air got to the under surface till in 1808 he studied the big water beetle and saw the use of the antennae as an aid in taking in air. He had 40 beetles.

The antennae seems to have no ordinary use, for in swimming they are held back along the side of the head while the palps of the jaws are used in front to feel objects. The antenna has a stalk and a club; the former is wet, the latter always dry and in air. The club is of 4 half-ring shaped parts fringed by bristles that make the organ a sort of tube. In addition there are short hairs over the surface of the club which prevent it from being wetted. Nitsch thus regards the antenna itself as forming a sort of open tube which lets air down from the surface into a reservoir when pumped in by movements of the wing covers and by movements of the abdomen and the thorax. Only one antenna is used as the beetle lies on one side, and it seems as if a silver thread (the air) passed down from the air above to the beetle's ventral side, between head and body. To see this clearly in smaller Hydrophilus it required a myopic eye. The big beetle often needs air and if long without it may put up its antenna and silver air thread when still far from the surface. The respiratory movements are remarkably vigorous and complex. The wing covers pump air down from above; the abdomen and thorax pump it in and out of the body.

Nitsch as professor of natural history at Wittenberg, in the spring and summer of 1808, showed these facts to his students, who took his lectures and demonstrations upon living animals, and also to many others interested in natural history. Everyone

was greatly interested in this respiration; some were greatly
delighted and said in a joke: it looked as if the beetle laid its ear
to the surface to hear what was going on out in the air. Indeed,
he had to give them some of his beetles so that they could ob-
serve them at home whenever they wished.

Miall, however, records, from his observations, a somewhat
different conception of the use of the antenna for he says the
antenna is held opposite the angle between the head and the
body, so that the air funnel is bounded on one side by the body
and on the other by the antenna, as if a man's arm and hand
were held to ward off (not a blow) but the surface tension that
would run in and fill the gap. "The film which bounds the im-
prisoned air is thus drawn upward and outward in the cleft,
following the movement of the antenna to which it clings. As
soon as any part of the unwetted terminal joints comes to the
surface, the film breaks and a passage is instantly opened from
the air above to the air space beneath."

Thus in time these various observers had accumulated over-
lapping series of facts more or less proved and corroborated. But
both the adult and the egg had been too little studied.

In time attention of the "egg and larvae men" was turned
upon the egg itself and the fine monograph of Heider on the
embryology of Hydrophilus sets forth the cell structure and the
origin of the embryo. This being more technical and requiring
instruments and facilities beyond those of the mere aquarium
student ranked as a scientific rather than a natural history study.
In it, however, Heider records his observations on the life history
as far as they incidentally arose in the collection of the eggs for
minute study. Heider doubted if the mast of the cocoon was for
respiration directly and suggested that it may serve to keep the
cocoon from being too much covered over by leaves and thus
shut off from the air. Within the cocoon he found 45-50 elongat-
ed eggs, each surrounded by a fine net of spun material. Above
the mass of eggs was an air chamber filled by the same spun
threads. The eggs stand upside down; the blunt end (which
became anal) upward; though the reverse was stated by Kowal-
evsky in 1871. The eggs are laid in the middle of May, but
copulation takes place much earlier, perhaps in the earliest
warm spring days, at least the receptacle of the female is full of
sperm in April. In the aquarium the copulation was seen in
February and March. The male holds the female by the first
and second legs, while the third legs make rowing movements

that propel the pair zigzag about, the male making a creaking noise.

According to Heider the way in which all the Hydrophilus beetles make their sounds was investigated by Kolbe (1877). He found the apparatus present in both male and female but in the male there were 230-240 fine grooves along the edge of the hind wing as compared with only 210 on the female. These fine grooves are played on by a ridge along the abdomen and thus the rasping note arises. The male and female often ride about thus whole days but the actual copulation lasts but a short time. In copulation the male ceased to row about and the female remained passive except that the hairs on the hind legs rubbed against one another and against the male organ. The male projects the penis and carries it forward and for an instant inserts it into the vulva, then withdraws it. This insertion and withdrawal was repeated 10-20 times and during this the male gave out a sound different from the preceding sounds in being louder and more shrill.

The cocoons were made each year with remarkable regularity as to time. In three following years Heider found the cocoon laid near Vienna between May 5 and 7. At Berlin the laying took place in two successive years, May 10. That is, the chief laying for Hydrophilus is done May 5-10. None were found before that though there were some laid later.

It is easy to get Hydrophilus in an aquarium to lay against floating dry leaves of various sorts or on potamogeton leaves and even on bits of cork. But too many beetles must not be in one aquarium, else they disturb one another in spinning. But once begun, the spinning cannot be disturbed. Heider says that it is important to catch the female immediately before laying, as females kept long in aquarium lay no eggs; as found to be the case in 1886 by Hallez. The eggs developed in 12 days, but in warm weather in 6 days, 12 hours.

Thus the life history of the big water beetle has had light thrown upon most of its successive stages at various times in different countries, but the end is not yet.

Those who wish pictures in place of the real objects will find some in the above mentioned papers and a life size view of the adults with the larva and the floating cocoon drawn for Brehm's Tierleben to accompany the description of the life history of this big water beetle. In this description the larva is cleared of its reputation for cannibalism on the ground that this results

from confinement in the aquarium; while in the open the larvae behave "viel friedlicher und furben gar nicht selten harmlose Spiele auf." Here also is mentioned that remarkable keel under the bottom of this boat-like beetle body. One can easily imagine experiments to test its usefulness. But the most comprehensive collection of pictures illustrating the life of this beetle is to be found in the inaccessible work of C. Wesenberg-Lund, entitled Insektlivet I Ferskevande, Copenhagen 1915. In this fine volume of 524 pages and 378 figures, the author has brought out his labors on fresh water insect lives during 1898-1913. Many of the illustrations are pen sketches and photographs by the author and many are copied. Thus in chapter XI the twenty pages given to the Hydrophilidae, ten of which refer to our big beetle, there are the figure of the larva from Miall, the cocoon spinning from Miger, four stages in the making of the cocoon about the body of the mother, redrawn from Reamur, two original photographs much enlarged of the spinnerettes of the female, the figures from Nitsch to show how the antenna works to draw down the air from above, three enlarged photographs of the antenna made by the author, a copy of the above mentioned illustration in Brehm, three original photographs to show the distribution of air as carried on the surface of the body of the beetle. Once more the old problems are worked over. The author has a long account of just how the antenna is used to get in the air. There is a brief description of the mating habits and of the making of the cocoon. The larva is described and its passing into the pupa state. Finally the adult appears and is recorded at various winter months abroad and in the aquarium.

He who will study as intensely as possible one or many incidents in the life history of this big water beetle will have some guides to find fault with and points of view that may well be modernized. But all this is but a suggestion for added use of the aquarium and this beetle is but one of very many examples of aquatic life, other than the favorite fish.

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ARITHMETIC IN THE JUNIOR HIGH SCHOOL.[1]

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The curriculum of the Junior High School must be determined
on the one hand by the needs of a developing civilization and on
the other by the nature and capacities of developing youth.
These two criteria of worth are by no means opposed to each
other. They constitute no bifurcated demand. They set up
no dilemmas. For every child is born into organized society on
the one hand and becomes a duly constituted member thereof,
while on the other hand, he possesses a social nature that fits him
into the world's work just in the measure that he finds himself.
It is perhaps not far afield to say that all friction due to anti-
social tendencies is a maladjustment of individuals who have
not discovered what they are good for. To select a school
curriculum then, we must study the problems that civilization
is solving and the work by which society maintains itself with a
view of discovering the appeals that training can make to the
capacities and tastes of a growing and expanding life.

Now when we examine industry we find it full of quantitative
problems without the solution of which at every step of the way,
no satisfactory progress is possible. Economies of production, of
exchange, of construction, call for constant investigation and
calculation. To reveal some of these data to the inquiring mind
of youth is to enlist their instant interest and to prepare them for
perseverance and endurance even though the solutions demanded
entail protracted effort and sustained attention. Young people
are just naturally interested in whatever makes the wheels go
round and will spend themselves eagerly in the effort to know
and to control dynamic things.

The traditional content of the text books mostly used in the
seventh, eighth, and ninth grades is notoriously unfit for ado-
lescents in some important respects, among which are the inclu-
sion of material foreign to their interests and the introduction of
extended and complicated calculations in order to make problems
different from and more difficult than those of the lower grades.
Much of the work for the seventh and eighth grades has been cast
in the same mold as that of the lower grades. It differs only in
degree and dreary useless complications.

Pupils leaving sixth grade have been taught the elementary
processes with integers; they have some knowledge of common
fractions; they have been taught a little regarding decimals. To

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[1] Read before the meeting of the Central Association of Science and Mathematics
Teachers, Chicago, November 27, 1924.

continue to ring these stale changes through seventh and eighth grades is threshing over old straw. Furthermore the introduction of extended and complicated business practice under the pretense of teaching practical applications of percentage correspond to no felt need. If pupils do not become apathetic or rebellious under such teaching it is because they have had all initiative smothered and have learned to plod unwillingly and unwittingly but obediently along the profitless way.

Nor is the sin against childhood any less in the usual ninth grade algebra. Pupils are plunged into abstractions that are not based upon experience and insight, so the floundering increases and the mortality rate of algebra classes is so high as to deserve the name the slaughter of the innocents. They drown because they are plunged into mathematical deep water before they have been trained to swim.

Now, seventh grade pupils deserve a better fate than to wade through the type of mathematics usually imposed upon them. Nature and industry are full of interesting problems making a quantitative appeal. We all move through a world full of the mechanical. We see material construction on every hand. We behold forces everywhere operating. Something or somebody is constantly arriving or departing. Reduced to their simplest terms, the problems that arise in this field are questions of space and time and motion. It is therefore high time when pupils reach the seventh grade that they be led to investigate the spatial elements of this busy, bustling, interesting world in a new and definite way. It is now time to acquaint pupils with some of the elements of precision in measuring, to train their powers to estimate distances and spaces, and in a word to train them in *quantitative appreciation*. Work with numbers cannot develop the mathematical sense: only the hand and eye training that comes from manipulation of spatial forms, solids, surfaces, lines, and points can furnish the basal experiences upon which the significance of mathematical value can rest. Numerical evaluation gets its meaning where and if used as subordinate to these more primary percepts. Then let us give seventh grade pupils mathematical instruments. Let them learn the use of straight-edge and compasses and protractors and linear scales including the metric linear scale,—not by studying about them but by using them as tools of investigation.

This would mean of course giving seventh grade pupils exercises in actual measuring with linear scales, using not only the com-

mon units yard, foot, and inch but the rod also as well as the millimeter, centimeter, and meter. A clear concept of the mile may be reached by exercises appealing to the constructive imagination and by drawings made to scale. Thus the conception of distance should be enlarged and elaborated on.

Pupils should be taught how to draw to scale after discovering the need for drawing to scale in platting or mapping at first familiar near-at-hand areas larger than the paper on which the drawings are made and later by representing larger areas and remoter distances. This will introduce to them some real and significant calculation with numbers having both intrinsic interest and immediate application. The interpretation of blue prints is suggested. The application to geography and varying scales of maps is evident. In geography especially an educated sense of distance is essential.

In mapping and planning there are three characteristic problems that appear. (a) If we are drawing to scale, we have given distances and a given scale. Any given exercise then is a series of constructions dependent upon calculating the required line segments from the given data, viz., the value of the actual line given to be represented and the given scale. Representing these elements by L, s, and l, we have given each time a distance is to be platted L and s to find l. Each operation is observed to be multiplying a given distance value by a given ratio or scale, hence we may generalize the operation by writing the formula, $l = Ls$.

(b) If we are using a map and a given scale of miles to find the actual distance between two cities, we have given l and s to find L. In this case we must divide the measured distance on the map, l by the ratio s (or multiply it by the reciprocal of s). Generalizing we write $L = l \div s$. This is division by partition. (A term value divided by a ratio.)

(c) A third problem may arise. Having a given plat or map and the actual thing or distance represented, we may desire to find the scale. In such case we must divide the platted distance l by the actual distance L. This time the formula becomes $s = l \div L$.

These three formulas with appropriate changes in letters will be recognized as typical of the three so-called cases of percentage. By substituting B, P, and R, for L, l, and s the formulas become (a) $P = B R$, (b) $B = P \div R$, (c) $R = P \div B$.

Again, if, in any multiplication problem, we call the product

P, the multiplicand M, and the multiplier m, we have (a) $P = Mm$, (b) $M = P \div M$, (c) $M = P \div M$.

If in any division problem, we call the dividend D, the divisor d and the quotient q, the formulas may reappear as (a) $D = dq$, (b) $d = D \div q$, (c) $q = D \div d$.

A study in angles and triangles requires the compasses and protractor. The properties of right, acute, and obtuse angles, of 45° angles, 60° angles are soon discovered. The method of dividing a circumference into sixths, into twelfths, into fourths and the consequences that flow from these constructions, the bisection of a line, the construction of a line perpendicular to or parallel to another are experimented with. In such a mathematical laboratory, experiment is followed by application and generalization and a real sense of mathematical values begins to find lodgment in pupils' heads.

Thus numerical calculation falls into its legitimate place as an evaluation of quantitative relationship so that that laborious ciphering which has hitherto been a forbidding and unwelcome taskmaster, takes the role of ministering to a felt need. Hence pupils gladly endure necessary drills because of the help they secure from the additional skill they acquire.

Pupils of the seventh grade are usually far from skillful with figures and facile in numerical operations. They need little additional instruction in technique, perhaps, if the work of the preceding grades has been well done, but they need loads of practice in direct and simple calculation, like ordinary adding of columns. They need gentle leading the snares of ordinary subtraction, in multiplying, and in long division. Measured graded daily practice, progressive in character, is needed in most if not all classes. This should be abstract in character and emphasis should be laid on accuracy, though facility and promptness should also be encouraged. Greater familiarity with common fractions and with the handling of decimals is also desirable and should be provided.

In the advanced seventh grade, there is a fine opportunity to apply drawing to scale to the making of simple graphs, line graphs, and bar graphs principally, and to open up the mysteries of percentage through graphing and diagraming. The study of percentage should return to whatever knowledge of decimals may have been previously acquired and should seek to illustrate and extend the same. Multiplication by pure decimal multipliers needs careful attention. The product of such a multi-

plication should be sensed as of less value than the multiplicand.
This is essentially the first case of percentage and may be the
basis for instruction in the same. (a) P=BxR.

Division of one number by another resulting in a pure decimal
quotient leads up to the so called second case of percentage.
The observation that division of whole numbers is not limited to
cases where the divisior is less than the dividend and that the
quotient need not be greater than unity and that any quotient is
really the expressed ratio of dividend to divisor may well be
made. This is the second typical problem, "Given two terms,
what is their percent relation?" (b) $R=\frac{P}{B}$ Another form of
this problem is "What part of a given number is another given
number?" Such examples throw light on this case of percentage.
This should be seen as a measuring operation involving a *stand-
ard* or measuring number, a *measured number* and a *resultant of
measuring*, or ratio, which ratio or quotient in such cases is most
frequently less than one.

Division of a whole number by a proper fraction or a pure
decimal typifies the third so-called case of percentage. Previous
to the experiences that series out of such percentage problems
the solution of such division problems has probably had only a
superficial formal meaning. (c)=P÷R. Finding the number of
which a given number is a given part is the significance of such
division. Finding a required number when a given part of it is
given, may be done by dividing the given part by the given
fraction (or multiplying by the reciprocal of the given fraction).
This so-called indirect problem is not easy to grasp and is not
stressed by some teachers, but it seems important to me because it
is so significant. It is really division by partition. The last
previous type or case II is division by measure.

In the advanced seventh grade daily practice with fundamental
operations, fractions, and decimals, should be continued as in the
beginning seventh grade.

For the eighth grade, I would suggest, a return to the
experimental, constructive exploration of spatial form. First let
such pupils study the kinds and properties of triangles and prac-
tice the various constructions and mensurations involved, then
let them proceed to study quadrilaterals in the same fashion and
perhaps to make some of the regular polygons by drawings,
paper foldings, cuttings and calculate the interior angles of the
same. This will lead naturally and easily to the study of parallels,
transversals and perpendiculars. The mensuration of the circle

and of cylinder might follow, but it seems to me the mensuration of the pyramid, cone, and sphere should be postponed for more advanced work.

By the time the advanced eighth grade is reached, some simple algebra might be systematized by gathering up formulas developed and used in the mensuration work already accomplished. If the convenience of letters as symbols of generalized or abstract numerical values is emphasized, then from this experience it should be an easy step to sense the convenience of representing any undetermined number by a letter and to translate the conditions of a simple algebraic problem from ordinary verbal language to the equational or mathematical form. The solution of such equations by a series of perfectly evident easily taken steps follows and thus without undue effort the algebraic "pons asinorum" has been crossed. These derived equations, I hold, should be reached directly and intuitively rather than by the time-honored but stale device of introducing axioms and laborious expositions of feats of balancing, of adding or subtracting equals. This is usually so formal and far-fetched, at this stage of the pupils' mathematical evolution, as to obscure direct relations that are easily seen. It is likely to substitute a sort of juggling for direct insight. Such contrivances may or may not be of some value when more advanced equations are reached but the purpose here is not so much to develop manipulative skill as to produce real insight into mathematical situations.

After pupils learn to translate from common language to equation form many simple algebraic problems and to reach an algebraic solution of such problems, some practice for them is legitimate that will fix the knowledge which has been acquired and stress simple manipulative skill. Such forms as the following are recommended.

$$3n = 12 \qquad\qquad 6x-2 = 4x+14 \qquad\qquad x/5 = 8$$
$$36 = 4b \qquad\qquad 140 = 8x+4 \qquad\qquad 2/3x = 16$$
$$3n+5 = 14 \qquad\qquad 20m = 40+12m \qquad\qquad 3x/4-2x/3 = 2$$
$$7m-8 = 43 \qquad\qquad 8n+4 = 6n+10$$
$$6x = 15-3x \qquad\qquad 13+x = 450$$

Verification of solutions by substituting in the first equation of a solution the value found in the last will lead naturally and easily to evaluation. The use of formulas in mensuration is really evaluation. So is the use of the percentage formula $P = RB$, the interest formula $I = prt$, the cost formula $c = pn$, the selling price formulas, $s = c + g$ and $s = c - 1$. This is perhaps as far in this direction as an eighth grade class should go.

A study of similarity of triangles and of other polygons and of solids develops the subject of ratio in a clear and graphic way. From the study of ratio and proportion as applied to the geometrical elements, further study of the subject as applied to other quantities, time, capacity, weight, money value, etc., is easily made and because of its analogy to the preceding study is easily understood.

Simple studies in indirect or calculated measurement, by means of similar triangles, height of buildings, widths of streams, can be introduced here. Height of trees or of poles may be calculated by comparing the shadow with a shadow cast by an object whose height is known, or, it can be done by taking an observation on the ground at a given distance from the pole, which observation determines the angle of elevation and includes a staff of a given length with its top in the line of observation; or, once more, the height can be determined by platting the distance measured on the ground platting the angle of observation or elevation and then measuring the platted height that results. This can then be reduced to actual height by means of the scale used.

All this is within the capacity of eighth grade pupils that have had the seventh grade course here laid down. It is suggestive, illuminating, deals with familiar elements of pupils' everyday experiences, and is much more interesting than solving problems in bank discount or the usual type of mercantile problem which most text-books spawn in such tiresome abundance.

A study of the relation of the hypothenuse of the right triangle to its other two sides, introducing not only the triangle whose sides are in the ratio of 4, 5, 6 but others with the ratio 5, 12, 13, or the ratio 7, 24, 25. Such a study with accompanying drawings to scale familiarizes pupils with the Pythagorean proposition in easy integral relationship, motivates the topic of square root, and furnishes an introduction to it that is clear, definite, and full of suggestion.

Since some business practice will be insisted on and since it has practical value, some attention may properly be given it. But it should be remembered that such practice is not properly mathematics, useful though it may be and is. Keeping accounts and the making of budgets are worth a modicum of time and attention. Likewise the topic of banking and familiarity with the methods of depositing, withdrawing, and borrowing or investing money and calculation of interest are commercial topics of value and worthy of study.

Daily practice in calculation with progressive exercises designed to increase accuracy and facility, recognition of short processes of calculation and readiness as well as accuracy should be insisted on unceasingly.

To proceed into the ninth grade would be to trespass on the territory of the paper that is to follow this.

FOREST SURVEY SHOWS SERIOUS PAPER PROBLEM.

Americans no longer can look upon the cheap daily newspaper as something inevitable every morning and evening. An extensive research just completed by the United States Forest Service has brought out alarming statistics on the depletion of wood pulp resreves in the United States.

American paper requirements now exceed eight million tons a year, or 56 per cent. of the world consumption. Wood constituted 90 per cent. of the raw material from which this is manufactured. In 1922, 9,148,000 cords were required.

American forests today supply only 49 per cent. of this wood. As recently as 1899 they supplied 83 per cent. Of the amount used in newsprint production, the domestic supply furnishes only one-third. Canada supplies the pulp wood for 37 per cent. of our entire paper requirements.

The forests of the older lumber sections of the United States are being out much more rapidly than they are replaced by new growth. In most regions the original timber supplies have been greatly reduced.

The problem as stated by the Forest Service is to secure annually from our own forests more than a million cords additional to offset pulpwood imports, approximately five million cords to offset pulp and finished paper imports, and to insure a sufficient growth to supply the needs of the future. It is estimated that a total of about 15 million cords will be required for this purpose by 1950.

Three possible solutions are suggested by the government: First, new or modified pulping processes may increase the number of species available for paper. Pine or larch, it is suggested, may be made to take the place of spruce, fir and hemlock in sulphate-pulp production.

Second, paper manufacturing must be conducted more economically. Reduced pulping waste in the chemical process, re-use of waste paper to a greater extent, and more coordination between the lumber and sawmill industries, must be aimed at. Only about 45 per cent. of the original wood weight now appears as pulp. Re-use of waste paper has grown to 29 per cent. of our total production, but it can be increased to furnish a much greater contribution than its present 1,850,000 tons a year.

Finally, the Forest Service states, "The main reliance in ultimately meeting our pulp wood requirements must be placed on the growing of timber. The possible margin of growth on our present area of forest land, under intensive forest management, over the present drain, would ultimately amount to about 12 million cords of the pulp species. To this could be added about 11 million cords now lost annually by fire and disease.

"To this could be added about 2,000,000 cords annually from Alaska. Out of this total could be met the 10% million cord difference between the present cut from our forests and the ultimate requirement of 15 million cords, and leave a substantial margin."

                                        Science News.

A COLLEGE COURSE IN GEOGRAPHY OF ILLINOIS.

By Wm. C. Gould,

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Geography treats of the relation of a social group to the area in which it is. It is not simply facts, nor a mass of hypotheses, nor a mere collection of parallels. It must be objective rather than subjective, or, as Dr. C. O. Sauer says, "It must be theme and not a viewpoint; scientific and not temperamental. It is concerned with the utilization of an area rather than with the influence of an area on man." To quote further from the same authority we note that this investigation involves three factors: —(1) Extent of Use, (2) Kind of Use and (3) Effectiveness of Use. Such topics as trend of population and wealth, stability, conservation, regional economy, etc., are special themes.

The modern trend of Geography seems to be rather away from the physiographic and geological and towards the economic and sociological. Bryce says, "Geography gathers up the results which the geologist, the botanist and the meteorologist have obtained and presents them to the historian, the economist and the politician ' but Ripley, in his "Races of Europe", says "The study of physical environment must, at the outset, clearly recognize its own limitations arising from the power of historical elements, of personality, of religious enthusiasm and of patriotism."

Some of the French Geographers have rather overestimated the importance of the historical approach to Geography of some regions. Incidentally I notice that the courses offered in a leading French University comprise some half dozen Geography Courses based on Europe, an equal number on Asia, four on Africa and ONE on NORTH AND SOUTH AMERICA. And yet the French complain that we are not sufficiently interested in France.

Illinois offers both distinct advantages and disadvantages as an area for special study. The modern idea is that an intense study of a very restricted area has distinct advantages over the cursory study of a great area. Professor Jones, of Chicago, says that now that he has attempted to study Patagonia and extensive sections of Southern Asia he is going to study Chicago and vicinity next. For such intense study a State may be too large but for the undergraduate, in less intense work, where the desired results are more general, a state may not be too large. Professor Ridgley says; "A geographical unit should be large enough to permit the development of the main lines of Geographic thought;

it should be small enough to be comprehended with accuracy and vividness in its statistical facts; it should be sufficiently diverse in physical and climatic conditions to lead to interesting contrasts. "Illinois is all this."

At the Ann Arbor Meeting of the National Council of Geography Teachers, Professor Branom of St. Louis presented an excellent paper on State Geography with special reference to Missouri, but with many general applications and suggestions that have helped me in planning this Course. For organization and method I drew extensively from a Graduate Course on "Geography of Michigan" that I took at the University of Michigan. It is one thing to name the materials that *could* be used in such a course and an entirely different thing to list the materials that were used and worth using again. A text, "The Geography of Illinois", was in the hands of each student, and this book by Ridgley played an important part especially when you take into account the fact that most of our students seem to know little about formal lecture work and are still considerably impressed with "the Book." The statistical work was based principally on the publications of the Fourteenth Census, especially those bulletins dealing with Illinois population and agriculture. State Geological Survey Bulletins, especially Numbers 15 and 27, were used; also a great variety of Maps put out by the Survey. Map filling can degenerate into mere busy work but it can be made to serve a most important function in College work. We used a large relief model of the State and one of the Chicago area. We also made effective use of such books as; "Starved Rock State Park and its Environs" by Sauer, Cady and Cowles, "Geography of the Chicago Area" by Salisbury and Alden, etc. Some railroads furnished us material of value, but literature sent out by Commercial Clubs and other booster organizations is apt to be over enthusiastic and not always absolutely reliable in the matter of statistics. An attempt was made to use the daily press and other current publications selecting such material as had geographical value.

It is understood that at least two quarters of Geography should precede this course for it is the policy of our institution to have a course in Principles and one in General Regional Geography precede all others.

Although most of our pupils have had no geology save what they have gleaned from Geography courses I see nothing impossible or undesirable in using considerable geological material.

Some structural, some economic and even some historical can be introduced and appreciated. We learned to talk fairly intelligently about the La Salle Anticline and its various types of expression as seen in the exposures near Dixon and La Salle and in the oil and gas fields of Crawford, Clark, and other counties where it is deeply buried. There are some fine geological profile maps that help to show these conditions. I see nothing at all impossible about learning the approximate extent of the Niagaran Formation. Is it too much to expect that a college student may know that three-fifths of the State has a rock formation referred to as the Pennsylvanian? The well drillers and many farmers know the sandstone by name and understand its economic importance. Certainly we can go as far, and I see no reason why we can not theorize a little as to its probable origin. When it comes to understanding conditions in the glaciated areas of the State, it is hard to see how much can be done without a fair knowledge of glacial geology. This is true especially of the Northeastern part of the State. A person might travel from De Kalb to Chicago and never know or care about the Bloomington or Valpariso moraines but when he has had his eyes opened to such things the landscape takes on new meaning and new interest.

The Physiographic division of the State offers a varied and interesting field for special study. The Lake Plain, the Morainal Plains, the Driftless Area, the Ozark extension and the Gulf Embayment, with their modifications and extensions, offer fields for study usually but little appreciated by the average student. Could such a study be supplemented by systematic personal observation it would be much more effective, but how can such things be?

Plant and animal life and its distribution are receiving deservedly more attention in the field of Geography. The person who puts down Illinois as a "prairie" state gets somewhat of a jolt when he comes to study vegetation conditions and finds that the region classified as "natural forest" is so extensive. Seventeen counties are counted as being entirely in the forest area and only three entirely outside. And is the rest true prairie? Perhaps the term "prairie" is correct, but the term "steppe" which fits the region immediately east of the Rockies can hardly be applied to any of Illinois. In 1919 Illinois mills sawed about 65,000,000 feet of lumber of which 35,000.000 was oak, 5,000,000 elm and 4,000,000 walnut. Only sixteen states cut more oak and only five more walnut. The total value of Illinois timber products in 1919

was greater than in Tennessee, Kentucky, Indiana, Maine, Georgia or Minnesota—all known as lumber producing states. Are not these facts worth knowing?

Some English Geographers, Unstead for one, have criticized certain publications called georgraphical by American authors. The grounds for this criticism lie in the fact that too much of the material is purely historical. History is not Geography but that there is a geographical basis for much of the history of Illinois seems to me to be absolutely clear. Did the Indians burn the prairie grass and forest edge periodically to increase the buffalo pasture? If so, we have there an illustration of a social group using their environment and modifying it too to their own advantage. Why were Illinois Indian towns located at certain spots along the rivers? If this was due to the fact that sandy soils could be cultivated by the Indian women while the regions of tough prairie sod could not, we have there a distinct geographical background.

Then there is that marvelous story of the French. The vision of La Salle in which he was allowed to see the possibility of a great inland, agricultural empire was based principally on his experiences in what is now Illinois. The death of La Salle and the loss of the New World by the French meant that many years must elapse before the tardy English settlers crept up the rivers from the South and settled in the rougher and more wooded sections, first, before trying the prairies, long regarded as a menace to health and areas of superstitious dread. When the Great Lakes began to contribute something more in the way of transportation a counter movement from the Northeast set in and development proceeded rapidly. To my knowledge there is no place where geographical influences on history are shown more clearly than in our own State.

For special studies of various kinds and especially for agricultural production certain counties were assigned to each member of the class, keeping the areas as complete physiographically as possible. One important set of maps was made to show percent of improved land devoted to the different crops. When completed these shaded or colored maps show very emphatically the centralization of corn in the Northeast Central part on the Wisconsin Moraine, of wheat farther South and West, of oats in the corn area and a little to the North, of hay in the dairying regions, of rye on the sandy soil, etc. Distribution of farm animals such as horses, mules, dairy

and beef cattle, etc., formed the basis for other maps. This type of work involving a certain amount of exact quantitative ideas and considerable computation is found to be remarkably instructive and effective. To know some of the possibilities and advantges of the use of statistics is one of the many requirements demanded of the Geographer, be he professional or amateur.

Just how much attention to pay to soil study is a problem I have not fully solved. Here is a study that ties into both the physical and the industrial. We made use of several soil maps of the State and various counties and tried to relate these studies to the uses of the land in these same areas.

Of course manufacturing and mining are both very important in Illinois, and both received their share of time and attention, but the beef packing, the iron industries and the coal mining received a lion's share.

As a special phase of the Transportation Problem each member of the class took some Railroad for special consideration, plotted main and branch lines on a base map and did what he could to study and report on such topics as terminals, cities en route, extensions outside the State, history, passenger and freight service, financial condition and probable future. The history of Canal and River transportation and the possibilities and advantages of revival discussed so much these days were given careful consideration.

The City of Chicago should have its full share of time, not only on account of its size and rank but also because of a series of curiously interesting conditions that have combined to make it important. Its remarkable physiography brought out so well in the model by Siebenthal, its relation to the Great Lakes and Great Plains, its relation to centers of population, area, and manufacturing, its rapid growth in spite of some local disadvantages, its history, present industrial expansion and future possibilities are topics each worthy of at least one lesson. We made a map of the State on which we indicated growth or decline of cities based on census figures of the last forty years. Many cities offered distinct problems, some of which were very difficult to solve. Each member of the class made a special study of the cities in his area and we all paid particular attention to the study of the ten or twelve largest.

The matter of distribution of population finds expression in many other ways besides in the location, size and growth of

cities. The general decline of rural population, especially in the
good farm areas, the increase in the size of farms, the distribution
of negro and foreign born population can be made to appear in
an almost startling manner when graphically expressed. For
example, the massing of the negro population into Northern
industrial centers is quite characteristic of our age, but on the
other hand the relatively high percentage of negroes in Massac
and Pulaski Counties shows the older type of negro concentra-
tion of the South. The lack of negroes in the mountains is a
negative expression of the same thing. In the northern counties
the number of male negroes seems to be greater than the number
of females. Perhaps this is but another illustration of the
industrial colonization promulgated by the Northern man-
ufacturers during and since the War.

Towards the close of the Quarter we spent some time comparing
the problems of Illinois with those of some of our chief com-
petitors and nearest neighbors. The following problems of our
State have distinct parallels in other states but vary greatly in
their seriousness:—

1. Soil Erosion in Ozarks. Compare Kentucky.

2. Great Coal Production and Reserves. Compare Penn-
sylvania.

3. Conservation of Forests. Compare Wisconsin.

4. Use of Cut-over Land. Compare Michigan.

5. Influence of a very great City on a State. Compare
New York.

6. Live Stock and Dairy Problems. Compare Wisconsin
or Iowa.

7. Price of Land and Land Tenantry. Compare Iowa.

8. Trend of Population from Country to City. Compare New
England.

9. The Negro Problem. Compare Missouri.

10. Iron and Steel Industries. Compare Pennsylvania or
Ohio.

11. Outlet from Lakes to Sea. Compare Wisconsin.

12. Revival of River Trade. Compare many States.

13. Good Roads. Compare any State.

An almost endless list of such problems and projects could be
considered and the outside comparisons help to fix the local con-
ditions in mind. Because of the ease with which statistics can
be obtained for states we are all apt to overestimate the import-
anceof a political boundary especially when it consists in a river.

The topics of State Government and Education have some place in the Geography of the State.

This paper attempts to give only those suggestions that are easily possible and clearly practical for a college class. New material is being collected all the time and I hope I am learning to use what I have more and more effectively. My chief regret is that we were unable to do any field work as a class. The course was given in the Winter Quarter. Most of the pupils were, to my notion, overloaded with work. However, I believe that such field work could be made a very important part of such a course. Another line of application which I was unable to follow out was the application of Illinois Geography to literature.

At the close of Branom's Work Book of Illinois he suggests that the pupils sing the Illinois State Song, as a sort of doxology, I suppose. We can hardly do that. I have suggested already some things that seem rather elementary for College classes but before even a modest structure can be raised a reasonably detailed foundation of facts must be laid. We need to lay such a foundation for our State Geography study. The idea is that from this time forth the pupil is constantly to add to his fund of information, that he will be alert to know the facts about his state and apply them in his daily work, in the performance of his duty as a citizen and in his contribution to society. It is with some such general aim rather than for some exact scientific object that this course of College grade in the Geography of Illinois has been planned and presented.

ELEMENTARY COURSES CORRELATE WITH NORMAL SCHOOL CURRICULA.

New curricular for the Connecticut State normal schools have been worked out by committees of the normal and training school faculties and the members of the State Department of Education. These curricula will bring the normal schools of the State into substantial uniformity, and they will be tried out during the current year.

At the same time that the normal-school curricula were undergoing reorganization, committees of teachers, supervisors, superintendents, and normal-school instructors were preparing new elementary-school courses of study. Each of the several subjects appears in a separate manual.

It is stated by officials of the Interior Department, Bureau of Education, that one of the significant contributions of these courses of study and the accompanying monographs dealing with principles and methods is that they correlate closely with the professional courses for the preparation of teachers in the State normal schools. This is expected to bring about a closer relationship between the teacher-training institutions and the work of the teachers in service.

SOCIAL VALUES OF HIGH SCHOOL CHEMISTRY.
By Theodore D. Kelsey
Grover Cleveland High School, St. Louis, Mo.

Someone whose wit is greater than his tolerance says that the point of most speeches lies at the intersection of the greatest possible longitude and the lowest possible platitude. In dealing with my subject I hope to avoid the greatest possible longitude, at any rate.

The greatest achievement of the teacher lies in his work as a builder of character. Besides giving competent instruction in the content of his subject, he must do what he can to make his pupils better fitted to do their part as social units in the complexities of present day civilization. Fortunately, the old, well-recognized principles of right living continue to be applicable, however great may seem the complexity of modern life, with its daily contacts multiplied many fold through the applications of scientific invention and discovery. Nothing that the teacher can contribute to the development of his pupils can be of more direct or more practical value than training in character, let their future vocations be what they will.

An executive of one of the largest department stores in St. Louis once addressed the St. Louis Association of Science and Mathematics Teachers upon the subject: "High School Education as a Training for Business." The speaker ranked training in character first, second and third in importance. In fact, this employer stressed the importance of character so strongly that he seemed to minimize the importance of special training in other directions. *What* the young men and women had studied, he maintained, was of less significance in qualifying them for the vocation of business than *how* they had done their work, and how well they had been grounded in the fundamentals of character. Apparently he had found it true in business, as we know it is true in school work, that those who have developed a proper and soundly based self-respect have a pride in excellence which will not permit them to do careless, slovenly work.

Leaders of education throughout the world are seeking to increase the efficiency of the schools in this vital work of character training. Allow me to quote three of the six recommendations bearing upon this subject put forward by the World Conference on Education, which was held at San Francisco in June and July, 1923.

"Whereas it is agreed that realization of the aims of the World Conference on Education will depend in a large measure upon the character instruction and training of the childhood and youth of the world, developing in them a sense of justice and an attitude of good will toward all mankind together with habits of action in accord with justice and love of humanity;

Therefore, be it RESOLVED: That this conference adopt in outline a basic plan of Character Education to be worked out in detail by each co-operating nation.

The following recommendations are respectfully submitted:

1. As to Research: That the educationalists of the nations be encouraged to inaugurate research work as to methods of character education so that the most influential ways and means for encouraging and guiding children and youth in their growth into right character may be discovered, and that exchange of knowledge as to effective methods of character education be arranged for between nations.

2. As to Objectives: (a) That character education in the school be regarded as essentially the problem of improving the conduct of children of school age at home and within the community as well as in the school. (b) That emphasis be placed upon the social give-and-take among children, on the principle that one should do unto others as he would have others do unto him. (c) That it is imperative that plans for character education provide for positively effecting specific improvements in particular acts of individual children. Character Education must, therefore, be concrete and objective. (d) That in this undertaking there should be the closest co-operation between teachers and parents; the parents being in the first instance responsible for the character training of their children.

3. As to Curriculum Materials: That since in all character development ideals and conduct are inseparable, the content of the curriculum should be so selected and organized as to provide definitely for development of ideals and attitudes that will stimulate conduct in agreement with approved moral standards. This will include ideals of truth and justice, and attitudes of kindness, love, gratitude, forgiveness, service toward associates, and ultimately towards all mankind. In the various school subjects, literature, language, geography, history, art, science, et cetera, there is a large opportunity to cultivate ideals and attitudes and to make clear the facts of universal interdependence of the human race and the debt of each individual to humanity as a whole."

Dean Milton Bennion of the School of Education, University of Utah, Chairman of the N. E. A. Committee on Character Education, classifies the objectives of character education as primary and secondary virtues. The primary, or foundational, virtues are set forth as love of God, love of fellowman (neighbor, mankind), and belief in moral standards and in the intrinsic value of the moral life. Among the direct corollaries he lists sacredness of human life, respect for the source of life and for the family as an institution, promotion of human welfare—justice, truth, honesty, sympathy, helpfulness, good will, appreciation, gratitude. Among the indirect corollaries are desire and search for humanistic knowledge (wisdom), and discovery of relations of cause and effect in conduct. As secondary virtues, those which have moral value only when properly applied, Dean Bennion lists obedience, health, temperance, self-control, courage, perseverance, patience, loyalty, courtesy, thrift, tolerance.

In what ways may the study of high school chemistry help toward the attainment of these objectives? It is evident that some of them may be reached more readily through other subjects in the curriculum, or through extra-curricular activities. However, chemistry can be made to contribute effectively toward the development of many of these virtues, both primary and secondary.

In common with other sciences, the study of chemistry should develop a love of truth and a desire for accuracy—desire to do a thing right because it is right, and not merely to meet the requirement for a good mark in the subject.

A spirit of open-mindedness is to be cultivated, and the need of weighing evidence before drawing conclusions. How often we see false judgments brought forward and injustice perpetrated in human relations because of hasty conclusions based on inadequate evidence. When we have a case in chemistry where the danger of this sort of thing is clearly brought out, should we not take advantage of the opportunity to point out how important it is in all phases of life to marshal an adequate array of facts before attempting to reach conclusions on important matters? When I recall the teachers of my high school and college days, I find that those who made the strongest impression upon me were those who could and did occasionally take us beyond the bounds of the subject matter and introduce some apt analogy from the domain of human affairs, showing that they knew not merely their subjects, but something of human nature as well.

The homely virtue of honesty is highly prized by all right-thinking men, whether as employers seeking honest employees, as employees seeking honest employers, or as citizens seeking honest men for public office. The president of a western college recently recounted a story which shows how the light of this virtue may shine like a beacon in time of stress. On a certain occasion a farmer's boy overheard Gen. Robert E. Lee tell some of his officers that he had decided to march against Gettysburg instead of Harrisburg. The boy telegraphed what he had learned to the Governor of Pennsylvania. The Governor sent a special engine to bring the boy to him. After the boy had repeated his story the Governor said: "I would give my right hand to know whether this boy tells the truth." A corporal spoke up, "Governor, I know this boy. There is no falseness in him." In a short time the troops were marching to Gettysburg, where they gained a great victory.

In our laboratory work we have excellent opportunities to inculcate this virtue of honesty. On the other hand, the pupil finds in the laboratory various kinds of opportunity for petty dishonesty. It is easy for him to get material for his laboratory notes from some one else in order to avoid the exertion of thinking things out for himself. It is easy for him to appropriate a beaker or a flask from a neighbor to replace the one he has broken, and so avoid paying for his own misfortunes or his own carelessness. Such misdemeanors, when we learn of them, make us feel the need of greater emphasis upon the fundamentals of character. It is difficult to determine accurately the effectiveness of any means we may use in trying to suppress dishonesty in the laboratory, but I believe that a few words from the teacher on this subject at the beginning of the term and again at intervals if apparently called for have a salutary effect. It would be inadvisable and inexpedient to preach a sermon. But it is possible for the teacher to set up frankly and concisely the necessary standards—to appeal to the self-respect of the pupils and to let them feel how contemptible such dishonest practices are. It is surely desirable to keep down to a minimum the number of pupils who leave our high schools after four years of work without an adequate sense of property rights.

Our laboratory work gives us an opportunity to emphasize the need of regard for the rights of others, beyond mere property rights. If a pupil can be made to feel that he must leave his station in the laboratory in good condition for those who are to

follow him, he has gained something in his sense of social obliga-
tions which has a good chance to "carry over" into his relations
with his fellows during his school days and in later life.   This
matter of training in consideration for others may perhaps seem
to be a simple thing, but it is out of such simple elements that
character is synthesized.

Moreover, though this may seem a simple objective, I must
admit that I have never been able to establish this principle as
the rule of action of all of my pupils all of the time.   In spite of
all that I can do, some pupils will carelessly misplace bottles;
some will, at times, leave ringstands or other pieces of apparatus
where they do not belong; and some will throw match sticks,
zinc, or iron sulphide into the sinks with an apparently sublime
confidence in the solvent power of water.   Later when the waste
pipes have become clogged, these pupils have before them an
excellent example of the relation between cause and effect in
conduct, but some of them are not as greatly impressed by it as
one might expect.   After trying various schemes for keeping the
laboratory in order, I have about reached the conclusion that
our best hope lies in a modified form of self-government.   At
Cleveland High School we are now trying, with some success,
the scheme of appointing certain pupils as Custodians of the
Reagent Bottles and others as Inspectors of the Sinks.   This
simple matter of proper care of public property and due con-
sideration of the rights of others is, I believe, of sufficient im-
portance to demand of each of us his utmost in persistence and
resourcefulness.   The habits of thought and action which we
are trying to establish along these lines make for those qualities
which are needed for good citizenship.

We expect pupils in chemistry to gain in their appreciation
of the applications of science to everyday life.   More than this,
we hope that this appreciation will function in the later life of
these pupils when they come to take up the responsibilities of
citizenship.   When the citizens of a community are voting upon
the question of issuing bonds for civic improvements, for a better
water supply, or for better provisions of any kind for health and
sanitation in the community, may we not expect those who have
studied chemistry to have a keener appreciation of the im-
portance and value of such undertakings and to cast their votes
on the side of progress?   When topics of this kind are up for
discussion in our classes it will do no harm and may do some
good for us to put in a word to indicate that we expect these
pupils later on to lead their communities in such matters.

The spirit of willingness to serve may be encouraged by allowing pupils to do things for the class. When certain solutions are to be prepared for class use, or when any of the other numerous occasions arise when something may be done by one or two for the benefit of many, there is presented an opportunity for training in service. In this I believe most of us have very little difficulty. Pupils are usually glad to do these things, and in doing them they often learn points in chemistry which they might otherwise have missed.

Throughout an experience of many years in the teaching of chemistry I can recall only one occasion when a request for service from a member of a class did not meet with a ready response. We were to have an experiment in which milk was needed. I asked one of the boys to bring us a bottle of milk from the lunch room, proffering the required lunch check to pay for it. To my surprise, he evaded and nominated someone else to do the errand. Thinking there might be some special reason for his attitude, I sent someone else, and after the class had started to work I had a talk with the boy who had refused. He explained that he never liked to go on errands to buy things— he never would do such errands for his mother.

"Are you embarrassed and do you hesitate to go into a store and buy anything for yourself?"

"Oh, no, I buy things for myself all right."

You can readily imagine the nature of the counsel which I gave him. Afterwards I watched this boy with considerable interest and was pleased to see a noticeable improvement. One day somewhat later in the term when this same class, in trying the action of lumps of lime with water, found that our supply of so-called "quick" lime had apparently passed over to be numbered among the dead, this boy volunteered to get some lime at a place near the school where a building was being erected. His service enabled the class to carry out the experiment successfully, and the boy himself no doubt benefitted most of all. When we consider the present state of affairs in general, including international relations, we feel that there is justification for the statement that selfishness is to-day the burden of the world. Any effort we may make to create a spirit of unselfishness in our chemistry pupils will be just that much added to the forces which are trying to throw off that burden.

Elements of real value for moral and social training are undoubtedly to be found in the study of the lives of those who

have built up the science of chemistry.   In the story of the lives
of such notable characters as Pasteur, Perkin, Mendeléef,
Berzelius, Richards, Ramsay, or Madame Curtie—to mention a
few at random—are to be found inspiration and guidance for
all of us, teachers and pupils alike.

Where could we find a better example of courage, determina-
tion and resourcefulness than in the account of Perkin, who, at
the age of nineteen, decided to start a factory for the manu-
facture of the dye which he had discovered?   Here was a young
man who had to devise not only the methods of production of
the dye on a commercial scale, but even the apparatus and the
means of securing the needed raw materials and reagents.   The
story of his success in overcoming all these obstacles makes a
strong appeal to the youthful imagination.

The spirit animating that great man, Pasteur, was one of
service to his fellowman—in that lay his chief pride and delight.
These words of his are characteristic: "But of this we may be
sure, that science, in obeying the laws of humanity, will always
labor to enlarge the frontiers of life."   A knowledge of the
character of Pasteur and some appreciation of his great achieve-
ments for the benefit of mankind should be part of the gain of
every high school student of chemistry.

It is stimulating to learn of the discriminating insight and
practical thoroughness of a Lavoisier, the broad grasp of a
Mendeléef, the patience and penetration of a Madame Curie, the
brilliant technique of a Ramsay, a Rutherford, or a Richards,
in their search for truth.   In high school chemistry it is, of
course, impossible to make an extensive study of the lives of
those whose names are linked with the great advances in the
science.   But if the teacher is familiar with their work and their
significant traits of character, he can, in a brief way, introduce
them to his pupils at opportune times with good effect.

It is good for us and good for our pupils to mount the heights
together occasionally, up the trails that have been broken by
sturdier feet than ours, up the steps cut in the rocky cliffs by
stronger hands than ours, up to the high places where we may
take a look around and "stretch our vision."

In so far as we are able, let us make the study of chemistry
bear out the statement that "education helps man to live in an
atmosphere of truth, which is at once a breath and a vision;
to make every day a microscope for studying the infinite pro-
fundities lying in a drop of water or in a grain of sand; and to
make every night a telescope for bringing the world of great
truths close by."

THE NECESSITY OF CHEMISTRY IN HIGH SCHOOL TRAINING.

By Chester A. Amick

Arsenal Technical High School Indianapolis, Ind.

The individual of today needs some special knowledge of chemistry. Through ignorance, we are saving at the spigot and wasting at the bung. The great strides of the immediate future will be seen in chemical rather than in mechanical perfection. Proof of this statement may be had by observing the mechanical perfection that is everywhere apparent. Picture the giant newspaper press, with its monstrous rolls, automatic fingers and multicolored printing ability. It prints, folds, and delivers papers to the distributing room faster than the eye can count. It works with the precision of an expert and with a speed that is astounding. If a part breaks, it is quickly replaced and another part is ordered from the factory. The old part could even be returned, remelted and recast, with little loss from the world's supply of raw materials.

But if we step around behind the machine, another and different picture greets the eye. We see immense rolls of paper entering quickly through the feeder and then, as in a dream, our thought strays to far off mountains, where axes ring, saws buzz, and the mighty forests are giving up to become the news carrier for millions. We follow the log-trains to the paper mill and there see one-half of the magnificent trees discarded as unfit for paper. Much of this is sent down the waste chute. Ten acres of beautiful forest, raw material not quickly replaced, is the toll for one edition of a great daily—one-half of which is wasted or partially used. What a saving if the chemist would but get busy.

The fate of a great industry often depends upon some simple chemical knowledge and initiative being shown by an ordinary day laborer. G. S. Brown in a recent review of the cement industry, states that in the beginning this industry had bitter competition with foreign goods. Some of the concrete did not hold up and the word was passed that the home product was inferior. Investigation proved that most of this was due to the fact that a contractor did not wish to discard a few loads of dirt-gravel mixture and the laborer did not wish to throw out the chunks of dirt. But dirt is not a good substitute for gravel in concrete and the product was blamed for the lack of chemical appreciation by the laborers.

Chemical knowledge is the enemy of "rule of thumb" methods. It does not accept the superstitions and prejudices that have been handed down in all industries, but seeks to ascertain the causes underlying the effects, which, in some cases at least, are produced with a considerable degree of regularity by these "rules of thumb" practices.

You would laugh if you thought that a glass factory should employ a "master teazer" who had many strange and useless additions to his batch, and sometimes even murmured incantations while mixing it, or chose the dark of the moon, or had a rabbit's foot in his pocket, thinking by these precautions he would obtain better results. It is laughable, although true.

As industry becomes more nearly chemically perfect, there will be a greater demand for all to know something of the science. We need chemically trained men to manage our factories, men in positions not wholly chemical, but places where chemical processes occasionally appear. Surely this should be a challenge to any high school offering a course in chemistry.

The chemistry of daily life, that which concerns foods and drugs, is of the utmost importance. We must know what to do with the things that surround us, or we waste not only finances, but even life. Think of the dairyman for a moment. He owns pure bred milch cows and is very proud of them. He knows the weight of each cow, the amount of milk that each produces daily, and the richness thereof. From data prepared by researchers, he can compute a ration for his thousand pound cow, add to it the additional amount needed for a 50 pound milk production of 5% milk, and wonder of all wonders, not over feed his cow, thereby causing her to gain in weight and increasing the cost of milk production. His is a business where competition is keen, and he studies his problems carefully.

But what of the home? We eat what we want, when we want, all that we want. We have little conception of bodily needs. In fact, we wax indignant that we should not eat a certain thing or that we should change our entire diet in order to help us be better able to do our bit. We frequently banquet, and because we hate to pass up so many rich and tempting morsels, we over estimate our capacity. Should we complain when the mother studies her family, trying to prepare a meal scientifically, that will please gastronomically? And will she not have better success in understanding the subject matter of a scientific food book, if she appreciates the chemical knowledge that this book is based upon?

Upon its success depends to a large extent, the health and happiness of a home, of a nation. And one would need to search long to find a business that was more fundamentally chemical, and that would show better results through the application of chemical knowledge which the future men and women could obtain in the high school. Not that I think that the student should know the relations of the amido compounds, etc., because that is impossible. But a knowledge of digestion, proper foods, and why the body fails chemically to keep up, if improperly treated, is essential to human efficiency, to national efficiency.

Many years ago, on the day before Thanksgiving, I overheard the country town druggist make this remark, "I wonder how many dyspeptics will be made by to-morrows feast." For the first time I pondered over the fact that one large dinner could break the digestive tract. But experience proves that the crystallized spring bolt in your automobile snaps upon hitting even a slight depression in the highway, even though it has withstood thousands of harder shocks previously.

What happens after the chain snaps? We trudge to the family physician, who looks at our tongue, hears our story, and writing a few lines that we can not read on a piece of yellow office paper, sends us to the drug store. The druggist truly compounds. He does not prescribe. He is interested in the dollar and cent side of the question. With the aid of the medicine and a little extra precaution, the system becomes stronger. But sooner or later, we again become careless and again the pains of indigestion force us to take notice. Relief we must have. But why go to the doctor? He will merely prescribe as before and add a couple of dollars to the bill. Medicine is medicine and the druggist is somethig of a doctor anyway. This time the druggist has a chance to prescribe. He thinks over his list of highly advertised remedies for indigestion, and finding the one that gives the largest net profit, produces it. The result is that we get a highly advertised medicine which owes the most of its curative powers to the advertising that is sent with it. And because it is highly advertised, we take it oftener and in larger doses, and soon we become a chronic absorber of patent medicines. Knowledge concerning this practice comes rightfully within the field of chemistry. The doctor talks against it, but we believe him as we believe the banker who warns us concerning "sure find" oil stocks.

This history of chemistry from the days of the mysterious alchemist until the present scientific miracle man has tended

to obscure the science. Many people believe that chemicals and drugs are all power-full, and that bodily good will result from their use, regardless of the ailment. And the popular conception is, that the more expensive, the prettier the container, the more nauseating the odor, the more efficient is the drug.

Only this fall, a student and his boy friend were visiting in the department. Mention was made of a preparation where two cents worth of inorganic salts sold in a paper package for twenty cents. The boy friend immediately spoke, "That's nothing. My father is a druggist, and he sells for over two dollars something that costs him only six cents to make."

Again, there is a preparation on the market, Anti-Fat, that actually upsets the stomach and makes one sick, so that the organ will not function. We eat but we can obtain no nourishment. This is good for the system, it certainly causes us to become slim. We feed ourselves, yet starve, and nature is compelled to call upon the reserve. But any person with sense will frown upon such a practice, and if he does not know better, he should have the opportunity of learning.

The traffic in patent medicines became so degenerate that a few yeas ago a Drug Act was passed for the protection of the public. But this has not proved equal to the occasion. Notice the following advertisement: "Arium. A new scientific principle for supplying to the human body the remarkable energy and power of genuine radium. Easy to take and economical. Arium has a stimulating and tonic effect, that is utterly different from that of any other drug or medicine known. It gives just the added force and power needed by the human body and is accepted by the blood, tissues, and entire system, just as withering plants accept sunshine and rain, and are revived by them. Arium feeds the body with energy like giving a fresh charge of current to a run down storage battery. The radium in a single arium table, for example, contains sufficient power to raise 100 pounds." . . .It is also said that there is sufficient energy in a single tear-drop on the cheek of a beautiful maiden, to blow up the Woolworth Building. "Apparently simply breathing the emanations from Radium keeps the miners free from rheumatism, and a hundred other maladies. Arium is not designed for sick people alone. In fact, *it is equally recommended for those who have no ailments. . . .*"

Again it remains for thoughtful men to insist that the public

be awakened to a broad realization of the value of chemists and chemistry. By so doing we can secure—

1. Better coordination among the researchers.

2. Better cooperation with the public.

3. Educate the individual so he may protect himself and realize the importance of the science to the nation.

Obviously, it is impossible to give this required training in college. It must be accomplished in the high school. And as chemical science is just coming into its own, that need is greater today than ever before. We are at the dawn of a new area in chemical education. It is beyond the scope of this paper to indicate how this is to be done. It is enough to indicate that the need exists, and that it exists in greater amounts today than at any other time in the history of man.

Individually the chemist has done much in the many branches of the industry. Collectively he has done little. Least of all has he been attentive to the problems of bringing up for the future of the profession, the needed younger men. And in conclusion, will you permit me to disgress from the subject and include a plea for the profession?

Chemistry offers a romantic field for study to the youngster who may desire to consider science as a life work. More effort should be made to encourage this selection. Recently there has been some such movement, but all too little has been done along these lines. As the chemist of today goes forward in his profession, advancing from year to year, in responsibility of position and size of organization directed, he will feel increasingly the need for younger men to assume direction of the details of his work. Unless there is soon a strong effort made to advance the professional standards in teaching, and to strengthen the college curriculum, a most distressing lack of talent will confront the executive in the not distant future. It will not be enough to have many students studying chemistry, although this will give a broad conception of the science to the public. Much greater, effort must be made to develop the quality of work done and the standards of performance required in the chemical curriculum so that the men coming out, will be the cream of our student body. In order that the best and most vigorous minds among the younger men will choose to go along these lines, the rosy future in opportunity for service and achievement must be clearly painted before their eyes.

CHEMISTRY BOOKS FOR THE HIGH SCHOOL LIBRARY.

By James H. Walton,

University of Wisconsin, Madison, Wis.

Chemical literature has been enriched to such an unusual degree during the past few years that a new list of reference books for the high school library is very desirable. Applications of chemistry to everyday life, moreover, are being emphasized more and more in the secondary schools, and as a consequence reference books on such topics as physiological chemistry, the functions of foods, household chemistry, etc., which were omitted from lists published a few years ago, now find an important place in these libraries. A further need of such a revision is evidenced by the fact that the war has focussed the attention of the public on chemistry as never before; popular interest in gas, smoke, explosives and other direct applications of chemistry in warfare has resulted in an interest in chemistry in times of peace. Therefore books which show the dependence of modern industrial development on experimental chemistry are of especial value in the high school library. The following list of books has been prepared at the University of Wisconsin as a suggestion for the high school libraries of this state.

The minimum list is intended for all schools. While many of the books in this list will be used by both teacher and students, an additional list of books primarily for the teacher's use is also given. Most of these are of a more advanced type, and should aid materially in broadening the point of view of the teacher, who has not specialized in university or college courses in chemistry. The more pretentious high school libraries may profitably add to their files the books included under the supplementary list.

The minimum list includes a number of standard text books and laboratory manuals, and in addition some of the recent texts which emphasize the applications of chemistry to daily life rather than laws and theories. Blanchard's Synthetic Inorganic Chemistry contains a number of inorganic exercises that are very useful for the more advanced students. They have been chosen and arranged to minimize the "cook book" element which is so often found in books of this type. The writer believes that the ordinary text book of physical chemistry is entirely too advanced for a list of this type. Talbot and Blanchard present the Dissociation Theory clearly and logically. In Hildebrand's Principles of Chemistry some of the most important

elements of physical chemistry are given simply and non-mathematically. The Inorganic Chemistry by Prof. Harry N. Holmes of Oberlin college is to be especially recommended for its lucid presentation of theory. The subject of "colloids" on which the author is a recognized authority is particularly well handled, while the descriptive matter is also excellent, and thoroughly up to date, containing material not found in the average text.

Mellor's Modern Inorganic Chemistry contains much information, but it is no sense an encyclopedic list of properties of elements and compounds. In the descriptive matter there is embodied much physical chemistry, non-mathematical in treatment and original in the manner of presentation. The remaining reference books under (a) are so well known and of such value as to need no especial comment.

The books under (b) Organic, are primarily for reference in the study of applications of chemistry to food, nutrition, etc. A text book of physiological chemistry, while dealing with the most involved organic chemistry, is very useful in this connection. "Chemist's First Aid Treatment" should be placed in the laboratory where every student will have an opportunity to read it. It will at least impress on him the fact that the substances he is working with are to be treated with respect.

The Scientific American Cyclopedia of Formulas, while not a chemistry book, has been included in this list because of the vast amount of useful information on glues, cements, paints, solders, insecticides and hundreds of other subjects. This book will be particularly helpful to the instructor in answering the multitudinous questions so often asked by parents and students.

Baskerville's "Municipal Chemistry" contains a series of non-technical lectures on such subjects as water supplies, milk, food adulteration and inspection, drugs, sewage disposal, paint, cement, concrete, etc. This collection of lectures was given at the College of the City of New York by such specialists as Dr. Harvey Wiley, W. R. Mason, and Maximilian Toch, and contains much valuable information for the progressive and thinking citizen.

The changes in Van Nostrand's Chemical Annual are hardly of sufficient importance to warrant its yearly purchase. However, the large amount of data condensed in this little volume makes it almost indispensible to have one fairly recent copy as a laboratory reference book.

The attention of the writer has been drawn to the fact that often the professional chemist first becomes interested in his science by reading popular articles similar to those written by the late Robert Kennedy Duncan. For this reason a somewhat extensive list of books of this type is given; of these, Dr. Slosson's "Creative Chemistry" is most up-to-date. The combination of the author's well known literary ability and his chemical training have produced a book that the writer believes to be one of the important contributions to chemical literature made in the past decade. The book is particularly interesting at this time because of the chapters devoted to the part played by Chemistry in the World War. An appendix gives many valuable references to magazine articles and books which have a bearing on the subjects discussed. The remaining books of this type will be found to contain much that is of absorbing interest.

The "Books for the Teacher" are for the greater part, too well known to need any discussion. The selection of these particular books is admittedly a matter of personal preference. In McCoy and Terry's "General Chemistry" attention is called to Chapter XXXII, "Radioactivity and the Nature of Matter." Van Klooster's "Lecture Demonstrations in Physical Chemistry" contains a good collection of simple experiments, many of which can be used as laboratory exercises for the more advanced students. Ostwald's "Conversations in Chemistry" has been found valuable to young teachers as an excellent illustration of teaching by the question and answer method. Frary's "Glass Blowing" contains detailed instruction in the manipulation of glass.

The periodicals of the American Chemical Society should be available for every teacher of chemistry.

The Annual Reports of the Chemical Society (London) may be obtained from the secretary of that organization, the price depending on the size of the particular book. The publication for 1920 was listed at 7 shillings. This report contains a digest of the most important work of the year in the following branches of chemistry: general, physical, inorganic, organic, physiological, agricultural. Crystallography, metallurgy and radioactivity are also reviewed. As a means of keeping up with the progress of chemistry these reports are invaluable.

Books in the Supplementary List should be purchased if funds are available.

Chemical dictionaries published in several volumes and costing between fifty and one hundred dollars have been intentionally omitted from these lists. It is felt that the books recommended, when supplemented by the many excellent articles on chemistry in the Encyclopedia Britannica will be quite sufficient for the needs of any high school library.

REFERENCE BOOKS ON CHEMISTRY FOR THE HIGH SCHOOL LIBRARY

MINIMUM LIST, for all Schools

Title	Publisher	Price*
History of Chemistry:		
Heroes of Science, Chemists. *Muir.* Thos. Nelson & Son		$ 1.50
Short History of Chemistry. *Venable.* Heath		1.60
Story of Alchemy. *Muir.* Appleton		1.00
Text Books.		
Chemistry. *Morgan and Lyman.* Macmillan		1.80
Laboratory Manual for above. Macmillan		1.00
Elementary Chemistry. *Smith.* Century Co.		1.80
Laboratory Manual for above. Century Co.		1.25
First Principles of Chemistry. *Brownlee and others.* Allyn and Bacon		1.25
Laboratory Manual for above. Allyn and Bacon		.75
Practical Chemistry. *Black and Conant.* Macmillan		2.00
Laboratory Manual for above. Macmillan		1.20
Synthetic Inorganic Chemistry. *Blanchard.* Wiley		1.50
The Laboratory Study of Chemistry. *Smith and Mess.* Holt		1.20
Chemistry in the Home. *Weed.* Amer. Book Co.		1.20
Chemistry of Common Things. *Brownlee and others.* Allyn & Bacon		1.50
Laboratory Manual for above. Allyn & Bacon		.60
Elementary Household Chemistry. *Snell.* Macmillan		1.90
Everyday Chemistry. *Vivian.* Amer. Book Co.		1.64
Theory		
Calculations of General Chemistry. *Hale.* Van Ostrand		1.50
Electrolytic Dissociation Theory. *Talbot and Blanchard.* Macmillan		1.25
Principles of Chemistry. *Hildebrand.* Macmillan		2.25
General Reference:		
(a) *Inorganic*		
General Chemistry. *Holmes.* Macmillan		3.50
Modern Inorganic Chemistry. *Mellor.* Longmans		3.00
Minerals and How to Study Them. *Dana.* Wiley		1.50
Outlines of Industrial Chemistry. *Thorp.* Macmillan		3.75
A Text Book of Elementary Metallurgy. *Hiorns.* Macmillan		1.40
Qualitative Chemical Analysis. *Prescott and Johnson.* Van Nostrand		4.00
Radioactivity *Venable.* Heath		.88
(b) *Organic*		
Organic Chemistry. *Remsen.* Heath		2.40
Chemistry of Food and Nutrition. *Sherman.* Macmillan		2.00
Practical Physiological Chemistry. *Hawk.* Blakiston		5.00
Text Book of Sanitary and Applied Chemistry. *Bailey.* Macmillan		1.75
Source, Chemistry & Use of Food Products. *Bailey.* Blakiston		2 00
Laboratory Experiments on Food Products		.35
The Chemistry of Plant and Animal Life. *Snyder.* Macmillan		2.25
(c) *Miscellaneous*		
Chemists First Aid Treatment. *Leach.* The Chemical Bulletin, Univ. of Chicago		.10

*Prices quoted are from latest price lists available.

Municipal Chemistry. *Baskerville*. McGraw Hill 5.00
Scientific American Cyclopedia of Formulas. *Hopkins*. Munn & Co.   5.00
Van Nostrand's Chemical Annual. Van Nostrand. 3.00
General Inspiration and Interest.
Chemical Invention and Discovery in the Twentieth Century. *Tilden*.
 Dutton 5.00
A Story of a Piece of Coal. *Martin*. Appleton 1.00
Chemistry in the Service of Man. *Findlay*. Longmans 2.50
Creative Chemistry. *Slosson*. Century 2.50
Gas and Flame in Modern Warfare. *Auld*. Doran 1.35
Modern Chemistry and Its Wonders. *Martin*. Van Nostrand 3.00
Modern Science Reader. Macmillan 1.00
Non-Technical Chats on Iron and Steel. *Spring*. Stokes 2.50
Scientific American. *Munn & Co*. Yearly subscription 6.00
Some Chemical Problems of Today. *Duncan*. Harper 3.00
The Chemistry of Commerce. *Duncan*. Harper 3.00
The Chemical History of a Candle. *Faraday*. Harper 1.00
The A B C of the Atom *Russell*. Dutton 2.00
Triumphs and Wonders of Modern Chemistry. *Martin*. Van-
 Nostrand 3.00

BOOKS FOR THE TEACHER

General Chemistry. *Deming*. Wiley 3.50

A Course in General Chemistry. *McPherson and Henderson*. Ginn   3.00
Introduction to General Chemistry. *McCoy and Terry*. McGraw Hill   3.00
General Metallurgy. *Hofman*. McGraw Hill 7.00
A Text Book of Organic Chemistry. *Holleman-Walker-Mott*. Wiley.   3.50
History of Chemistry. *Moore*. McGraw Hill 2.50
Outlines of Theoretical Chemistry. *Getman*. Wiley 3.50
Theoretical and Applied Colloid Chemistry. *Ostwald*. Wiley 2.50
Quantitative Chemical Analysis. *Olsen*. Van Nostrand 4.00
Lecture Demonstrations in Physical Chemistry. VanKlooster 2.00
Lecture Experiments. *Newth*. Longmans 3.00
Conversations in Chemistry. *Ostwald*. 2 Vols. Wiley 3.50
The Teaching of Chemistry and Physics. *Smith and Hall*. Longmans   1.90
Laboratory Manual of Glass Blowing. *Frary*. McGraw Hill 1.00
Periodicals.
Annual Reports of the Progress of Chemistry. Issued by the
 Chemical Society (London) ....
Chemical Abstracts 7.50
Journal of the American Chemical Society 7.50
Journal of Industrial and Engineering Chemistry 7.50
School Science and Mathematics 2.50

SUPPLEMENTARY LIST

Food Inspection and Analysis. *Leach & Winton*. Wiley 8.50
Treatise on General and Industrial Inorganic Chemistry. *Molinari*.
 Blakiston 12.00
Treatise on Chemistry—2 Vols. *Roscoe & Schorlemmer*. Macmillan   15.00
Manual of Industrial Chemistry. *Rogers*. VanNostrand 7.50
Essays in Historical Chemistry. *Thorpe*. Macmillan 6.00
The Condensed Chemical Dictionary. The Chemical Catalog Co...   5.00
The Gases of the Atmosphere. *Ramsay*. Macmillan 3.00

With the annual output from her clay-product industries valued at
$31,000,000, ranking the State second only to Ohio in pottery, tile, glass-
ware, and other ceramics, Pennsylvania is meeting the demand for train-
ing in these industries by offering a four-year course in ceramic engineer-
ing at the state college. Ohio, New York, and New Jersey all support
well-established schools of ceramics.

TIMBER PRESERVATION—A FORM OF FOREST CONSERVATION.

By F. C. Bohannon,

High School, Galesburg, Ill.

Theodore Roosevelt and Gifford Pinchot did the people of the United States a great service by calling attention to the problem of conservation of our forests. The Forester now has his work well organized and under way; it remains for the work of timber engineer to be recognized by the public and for his methods generally to be adopted, to complete the program of conservation.

Saving the supply of timber already grown is doubtless as important as growing a new supply. U. S. Bulletin of Agr. No. 112 is responsible for the statement that we are using 40 billion feet of lumber and 87 million hewed railroad ties annually, besides pulpwood and fuelwood. W. B. Greeley, chief of the U. S. Forest Service, urges preservative treatment of railroad ties, mine timbers, fence posts, telegraph poles, shingles and construction lumber. He endorses an estimate of 3,650,-000,000 board feet as the annual saving by this method. The importance of saving becomes significant when we are told in the same bulletin that "We are taking about 26 billion cubic feet of material out of our forests every year and growing about 6 billion feet in them."

Our outgo in forest resources is more than our income. Bankruptcy of natural forest resources is inevitable unless we face the situation and save what we have. First, we can produce more: every state has its program of forestation, but without hope of catching up to increasing demand in an economically active country. We are now using one half of the consumption of forest products of the entire world. Yet in the state of New York, as reported by its conservation commissioner, the number of wood-using factories including furniture factories, agricultural implement plants, and concerns using lumber in the form of plank, had shrunk from 3300 plants in 1913 to 2200 in 1900, 1100 industries having gone out of business in six years.

We can use less timber; the older nations of the earth have reduced their consumption to a very low and stable level; these countries are industrially stagnant; but industrially active countries such as England and Germany are great wood consumers. We must not consume less at the expense of useful industries. We can substitute other materials for wood, such

as cement for watertroughs and piling, steel for bridges, imple-
ment frames and tongues. Galesburg's shale is being converted
into paving bricks which are taking the place of wood blocks in
her own streets and in the main streets between here and Panama,
where a large consignment of Galesburg brick was used. But
with all the substitution, important as it is, the saving affected
is estimated by W. B. Greeley at only 150,000,000 cubic feet
or about one half of one per cent of the drain upon lumber.
We can, by preservative treatment, effect the largest saving
as indicated above. This saving of lumber is secured mainly
along two lines, first by increasing the average life of timber
four or five times, secondly by allowing the use of inferior woods;
such as rapidly growing cotton wood, as railway cross ties in
place of slower-growing, relatively important white oak.

Preservation was secured in the old days by applying tar to
the outside surface with a brush. Nowadays, the same material
is utilized in the form of creosote oil, a coal tar product forced
into the wood under pressure and at a high temperature and
made to penetrate into the heart-wood of the tie or pile thus
lengthening the life of the timber which is equivalent to increas-
ing the visible supply. The following treatments are used at
the Burlington tie plant, Galesburg, Illinois.

First: Straight creosote
Second: Card process (zinc chloride and creosote)
Third: Burnettizing process (zinc chloride)

Mr. J. R. Waterman, Supt. of timber preservation for the
Burlington road, recommends the first or creosoting process
as being the most effective, but because of the lessened cost he
recommends the card proxess, from an economical stand point.
The relative merits of the above processes are submitted below
from data compiled by Mr. Waterman.

One of the oldest examples of creosoting timber under condi-
tions similar to the present practice is that of the New Orleans
and North Eastern Railroad across Lake Pontchartrain, 5.82
miles in extent. The piling of yellow pine, having not less than
12 inches of heartwood at the head, were treated with from 10
to 12 pounds of creosote per cubic foot at a temperature of 175
degrees under a pressure of 150 pounds per square inch after
steaming and vacuum treatment. A report of the Interstate
Commerce Commission Valuation Division Engineer, in 1918,
makes the following comment. "A very remarkable state of
preservation—the original timber in good condition and ap-

parently carefully selected and well creosoted—estimate re-
maining service life of this trestle thirty-five years." These
pilings had already had a life of thirty-five years, making a
total expected life of the trestle seventy years.

In order to understand what has happened to the tie or pile
when treated according to the specifications sketched above, a
description of an up-to-date plant and processes used follows.
The main features of a modern wood preserving plant are, first,
the ten or dozen huge cylinders, 6 or 7 feet in diameter and 120
feet to 140 feet long. These retorts are mounted on heavy
concrete bases which are not continuous but allow more or less
access below the retorts. There are doors at one or both ends,
which, after the admission of timber to be treated, are closed
by fifty large steel eye bolts. Tracks extending from the storage
yards approach the entrance to each retort, where a gap of about
8 feet is bridged by a movable car in a pit. This car bears a
section of track, continued in a well at the bottom of the retort.
When the door of the retort is to be opened, the carriage bearing
a section of the track is removed allowing it to swing open
readily. The well contains pipe connections to tanks of treating
fluids, air compressors, steam pipes, etc. The engine room,
which contains all necessary pumps and generating machinery,
is located in an adjoining room on re-enforced concrete founda-
tions. One of the most interesting of its varied equipment is
an elaborate system of automatic recording apparatus, a steam
meter showing steam consumed, thermometers, pressure cages,
and the like. By means of these ingenious devices a complete
record of temperature and processes is made on circular discs
from day to day and filed away for future reference. (By
courtesy of Mr. Shinn, Superintendent of the Galesburg plant,
I am able to exhibit a card showing temperature and pressure
record.) Adjacent to the main plant is to be found huge tanks
having a capacity, in case of the Galesburg plant, of one half
million gallons each. In addition, the Galesburg plant has a
mixing tank into which creosote, zinc chloride, etc., may be
pumped in desired proportions. The treating fluids are ob-
tained from standard dealers, such as The Tar-Via Co. Much
of the creosote has been produced as a bi-product in Germany.

Timber to be treated is seasoned by piling in the open for about
one year. The ties are stacked cob-house fashion so that air
will circulate freely and rain water will run off readily. No
successful method of treating green timber has yet been devised.

The tie is next placed on low cars or cradles in compact form so that the encircling hoops when packed full will fill approximately the bore of the retort. A series of the cradles are coupled together and drawn into the treating chamber by a wire cable, the power being supplied from winding a drum. The retort is closed, and steam is admitted for a period of one or more hours according to the size and nature of the material treated. This process effects an even distribution of moisture an insures uniform drying. Excess water which accumulates is forced into outside tanks, since the pressure in the retort is greater than in the tanks.

The second step in the treatment is the creation of a partial vacuum. This is a real drying process, as evaporation goes on rapidly where a vacuum of twenty inches or more is maintained. The third step is the admission of creosote oil, at first without pressure; afterward the pressure is brought up to 175 pounds or more; later the oil is forced back to the working tanks from the retort by compressed air, the door is opened and the load drawn. The wood has absorbed about 12 pounds of creosote oil per cubic foot and has been made so heavy that it will sink in water. How complete is the penetration of the fluid is shown in the cross section (Exhibit 1) of a pile which shows that every portion of the pile has been affected, with small areas at the side of the center showing less pronounced effect.

The charge after being with-drawn is stacked in the open in the material yards until it is needed. Power derricks which lift the entire contents of a cradle are used in loading and unloading ties. Where the loading of ties in a box car preclude the use of power an ingenious trolley system facilitates the rapid loading by hand.

The results obtained by Mr. Waterman in timber preservation are set forth in his recent report to the officials of the Burlington road, from which report the following conclusions are presented: That there are two causes for the failure of ties, first, decay due to moisture, etc., second, failure due to mechanical causes. Since moisture is a great factor in decay, observations by the above authority show that ties last longer, other things being equal, west of Nebraska points than east. Observations of recorded portions of track show that such woods as hickory, poplar, cottonwood, elm and red oak compare favorably with white oak, as ties, when given preservative treatment, whereas the tendency of each of these woods to decay when in

contact with damp soil is common knowledge. The accompanying chart (after F. S. Shinn, Superintendent of the Galesburg plant) shows that of 3,200 zinc-treated ties, only 15% had been removed after 17 years, while 26% remained in service after 22 years, whereas untreated ties are shown to last about 5 years, in case of white oak, and less time in case of the woods mentioned above. The preservative treatment, then, conserves both timber supply and replacement costs.

An examination of the table appended will make apparent how inferior woods, by treatment, may be made to do the work of the more expensive and relatively-scarce white oak ties.

When treated by the most commonly used card process the following show that other woods compare favorably with similarly treated white oak ties, in serviceability. Where under similar conditions, 8.8% of a number of white oak ties were removed on account of decay and 11.8% for other causes. There were removed:

	From decay	Other Causes
Cottonwood	2.7%	15.5%
Hickory	6 %	21. %
Elm	2.5%	6.8%
Red Oak	3. %	11.3%
Poplar	7.3%	30.1%

Untreated, the score for the same woods is very poor in comparison with white oak. There were removed from trial sections of track after exposure:

Untreated	From decay	Other causes
White Oak	61.5%	10.3%
Hickory	92.3%	7.7%
Elm	93.8%	6.2%
Poplar	95.1%	3.71%
Red Oak	96.1%	3.1%
Cottonwood	96.5%	3.5%

There follows a more complete report on these woods as ties subjected to identical usage in an observed portion of tracks:

Process	Number of Ties	Removed	Decay	Other causes
EAST				
Creosote	2,027	140	2.8%	4.1%
Card	10,259	2,003	5.9%	13.6%
Burnettizing	1,584	526	19. %	14.2%
Untreated	2,040	1,963	88.9%	7.3%
WEST				
Straight Creosote	1,117	107	7. %	8.8%
Card	4,929	1,099	5.9%	16.4%
Burnettizing	842	273	9.5%	22.9%
Untreated	1,075	1,033	89.4%	6.9%
ELM				
Creosote	206	13	2.9%	3.4%

Card	597	56	2.5%	6.8%
Burnettizing	224	28	7.2%	5.3%
Untreated	112	112	93.8%	6.2%
HICKORY				
Creosote	10	0	0%	0%
Card	185	50	6 %	21 %
Burnettizing	16	0	0 %	0 %
Untreated	65	65	92.3%	7.7%
COTTONWOOD				
Creosote	88	3	1.1%	2.3%
Card	296	54	2.7%	15.5%
Burnettizing	56	56	96.5%	3.5%
RED OAK				
Creosote	164	4	0 %	2.4%
Card	777	111	.3%	11.3%
Burnettizing	159	35	6.3%	15.8%
Untreated	128	127	.96.1%	3.1%
POPLAR				
Creosote	50	2	0 %	4.0%
Card	396	148	....	30.1%
Burnettizing	50	20	20 %	20 %
Untreated	81	80	95.1%	3.71%
WHITE OAK				
Creosote	15	0	0 %	0 %
Card	136	28	8.8%	11.8%
Burnettizing	15	3	6.7%	13.3%
Untreated	39	28	61.5%	10.3%

Data furnished by F. S. Shinn, Supervisor of Galesburg tie plant and J. H. Waterman, Superintendent of Timber Preservation, C. B. & Q. R. R.

THE TEACHING OF OSMOSIS AND ITS PHYSIOLOGICAL FUNCTIONS.

By Charles J. Lyon

Dartmouth College, Hanover, N. H.

Plant nutrition is so important a part of plant physiology that it deserves an accurate consideration in advanced courses and more than casual treatment in courses in elementary botany. The two main divisions of nutrition are, of course, (1) the raw materials and products of photosynthesis, and (2) the mechanics of entry, internal movement and food manufacture. By the use of rather simple chemistry the several essential elements and compounds may be described to the elementary student and elaborated for the student of physiology but the physics and mechanics of their entry and transfer can not be disposed of so neatly. This difficulty may be attributed partly to our incomplete knowledge as to what forces really act within the plant, and partly to the necessity for being both accurate and concise in portraying the action of the forces that are fairly well understood. This criticism is of the current practices in presenting, by texts or

lectures, the applications of osmosis to the mechanics of plant nutrition.

The facts about osmosis and osmotic pressure are certainly well-known to all teachers as are its almost unchallenged relationship to diffusion and diffusion tension. It would appear to be possible (though not easy) to so organize the known facts and illustrations of diffusion, diffusion tension and osmotic pressure, that they could be outlined in logical sequence, illustrated by experiments and grasped (perhaps only memorized) by the student. It does not then seem far to an appreciation of what materials enter or are transferred within the plant by diffusion, and of what elements may be said to depend for their movements upon the limited case of diffusion which is termed osmosis. The problem of turgor or turgidity is to be treated at the same time and its basis established upon the same principles. And when such an excellent organization and statement of applications as is contained in Livingston's monograph, "The rôle of diffusion and osmotic pressure in plants," is available, it seems strange and lamentable that teachers can not agree upon and teach the principles and applications so clearly stated in that book. My experience has been that they do not agree upon some of the most important points and that the teaching of the topic needs some corrections.

Some time ago I sent to forty college teachers of botany and plant physiology a request for statements of their teaching practices for portraying or defining osmosis and functions in nutrition. I submitted some definite questions that were intended to emphasize the features of the applications over which I have heard, or seen statements of, marked differences of opinion. Four of the nine questions asked dealt with the point, "What does osmosis cause to move into or within the plant, particles of water, inorganic food materials such as nitrates or calcium, or both?" Other questions dealt with the exact statement of osmosis, its relation to diffusion, the substances (other than water) responsible for turgidity, and texts and reference books used. Before asking the questions I was of the opinion that the greatest confusion exists over the exact materials that move by reason of osmotic action and the answers received from 19 men in 16 states showed it to be true.

By taking from each opinion received, its declaration on each of several important points in the definitions and details of applications, I have been able to record what appears to have

been a representative vote of American teachers on those points. The results listed below show with what unity they teach the topic. It was impracticable to classify them into even two groups but I could detect no greater differences of opinion between the avowed non-specialists and the acknowledged specialists than were present between the specialists.

1. As to the nature of the membrane used in osmosis or that which brings about osmotic pressure

> 13 said semi-permeable membrane
> 5 said membrane
> 1 said permeable. membrane

The vote here left a safe margin for the kind of membrane that must be present to exert the influence that results in the retention of the particles of the solute whose efforts to escape give the pressure which we call osmotic pressure. But those of the minority who give the looser definition or description of conditions. often write the textbooks or so instruct the students as to leave many unprepared to appreciate the action within plant cells.

2. One of the questions asked the relation of osmosis to diffusion. It was included along with other questions that overlapped it in order to get a very definite answer.

> 17 said osmosis acted as the result of diffusion or words to that effect.
> 2 said osmosis is "passage" of the water.
> More detailed analysis of the answers brought out these distinctions:
> 11 said that osmosis is a special case of diffusion.
> 4 said that osmosis is same thing as diffusion.
> 1 said that osmosis is the first stage of diffusion.
> 1 said that diffusion is one of the features of osmosis.
> 1 failed to indicate any relationship.

Aside from some of the scattered votes, the main idea is the same except that some refuse to separate the two principles even to the extent of making osmosis a special case by reason of the membrane. I shall speak of this later and only note here that such an attitude or method does not help to give a detailed picture of the entry or movement of particular elements.

3. As to whether the entry of substances into plants (aside from the entry of gases through aerial parts) is accomplished by osmosis or by diffusion, there was the following division of opinion:

9 said both solutes and solvents enter by osmosis.

9 said just solvents enter by osmosis.

1 said nothing enters by osmosis.

One can not help but wonder if teachers are really as evenly divided on this point as this small vote indicates.

4. After the solvents and solutes are taken into the cells of plants, presumably epidermal cells or root-hairs, it is then a question of mechanics of transfer to other cells. Concerning the basis for this movement within the plant, 3 of the 4 who said osmosis and diffusion are the same thing, said this question has then no point. Of the other 16

8 said osmosis moves solvent only.

6 said osmosis moves both solvent and solute.

1 said osmosis moves nothing.

1 gave no answer.

5. One of the phases of the functions of osmosis in the life of cells is that of its relation to turgidity. Even while the water and solutes are entering them, they must remain turgid. The vote on the substances within the cell that induce turgidity by taking water into the cell, resulted as follows:

12 said it is done by both organic and inorganic solutes.

4 said it is done by organic solutes only.

3 misunderstood my question and gave no answer.

This analysis appears to show a real confusion in teaching practices if not in the thinking of the teachers who may have decided upon a method that can be justified because it works. There are some who are aware of variations in the handling of the topic and who insist that there is no discrepancy; that osmosis is diffusion, governed by the same laws and responsible for the same movement of materials from place to place. The best usage to come from that line of reasoning would be to drop the term osmosis (in botanical teaching) and in application, declare that the food materials of plants diffuse into them from their immediate surroundings. It would remove some of the difficulties of presentation to so explain matters but one would certainly have to handle the topic of turgidity with care and prepare to give to the thinking, inquisitive and insistent student, a statement that would be in accord with what he has been taught in chemistry or physics where osmosis is elaborated upon. For the consideration of those who would like to keep a distinction, to attribute to osmosis certain accurately defined functions and to leave to diffusion the phenomena of such movements of particles

as do not depend upon the presence of a "semi-permeable" membrane, the following program is offered.

1. *Diffusion and diffusion tension.*

Describe diffusion of gases and of liquids. Review the kinetic theory of matter briefly if necessary. Emphasize the tendency of particles to move to points of lesser concentration rather than the governing principles of temperature, etc. Show how this diffusion tension of substances is independent of the presence and diffusion tension of other substances.

2. *Conditions within liquid solutions.*

Without going into the theory of solution, describe (with the aid of diagrams) the distribution of particles of solute and solvent in a dilute aqueous solution of first, non-electrolytes and then electrolytes. Avoid stressing the electrical features of ionization in order to keep the attention on the particles of water and salt and their relative numbers according to concentration.

3. *Osmosis and osmotic pressure.*

Describe (and demonstrate if possible) a simple case of osmosis involving a sugar solution within a membrane that will satisfy the requirements of the term "semi-permeable," with the membrane partly immersed in water. Relate all tendencies to movement to the difference in diffusion tensions on the two sides of the membrane. Point out clearly that the resulting increase in volume of the solution is due to the entry of water and that this is one of the principal results where osmotic phenomena occur. Explain the balance of forces between the diffusion tension of the retained sugar particles and the resilience of the walls of the membrane, and that the outward-acting pressure can be called osmotic pressure. Then present as much detail of the increased pressure in the case of electrolytes, of the differences in membranes, of the effect of temperature and concentration upon the osmotic pressure, of the theory of the entry of the solvent as related to the action of the membrane, of the measurement of the pressure, etc., as the needs of the student require and the nature of the course permits. Leave with the student the idea that osmosis takes place by reason of diffusion acting about and through a particular kind of membrane. Emphasize the points that a membrane is semi-permeable only in respect to definite combinations of certain solvents and solutes and that particles may and often do, diffuse through membranes without causing osmotic pressure to develop. This is simple diffusion while osmosis is more than diffusion and has some features that are not yet understood or explained.

4. *Osmosis and diffusion as forces in plant nutrition.*

(a) Absorption of water. The water lost through the aerial parts of land plants is replaced by that taken in through the roots which are in contact with the dilute soil solution. The concentration of solutes within the cell is usually higher than that of the soil solution. Since the plasma membrane is known to act as a semi-permeable membrane between the solutes within and the water of the soil solution, as is shown by tests for outward diffusion and by its turgidity, every condition is present for osmosis to take place and water is thereby taken into the epidermal cells. This is certainly the case where the rate of entry is slow but it is also quite likely that water moves into roots by mass streaming. This explanation accounts for proven cases of entry too rapid to have been accomplished by the relatively slow rate of diffusion of water in the action by osmosis.

(b) Absorption of solutes. Gases diffuse according to certain laws until they enter into solution when they behave as do dissolved particles of liquids and solids. These particles have a diffusion tension that alone accounts for their movement from the soil solution to the interior of the root cell except in so far as they may be brought in by the mass streaming mentioned above. Provision for continued diffusion from soil to root is made by some method of removal to the solutes from a dissolved to an insoluble condition or by their passage into other cells. In either case the diffusion tension of a given solute is greater without than within the cell as long as the solute enters. Osmosis has never been shown to move a solute so that if the term is retained to picture the entry of water it must not be carelessly used for the entry of other nutrients.

(c) Transmission of water from cell to cell. Aside from the unknown or possible relationships of osmosis and diffusion to the upward-moving current in vascular plants, the intercellular passage of water is due to its osmotic movements until it reaches a cell that has no adjacent cell with a higher concentration of solutes. At that point all our knowledge of diffusion and osmosis fails to indicate how either can effect a further movement of water. Some suggestion of the nature of a mass streaming through the plasma membrane may be used to fill in this gap in our knowledge.

(d) Transmission of solutes. As was shown in the case of absorption of solutes, osmosis can not move them and simple diffusion plus possible mass streaming accounts for transmission

from cell to cell. Within the cell, streaming movements of the protoplasm aid in equal distribution. That one solute may diffuse independently of every other is to be assumed from the lack of interdependence of the diffusion tensions of several solutes.

(e) Turgidity. The cause for the turgid condition of living cells is the internal osmotic pressure developed by reason of the surrounding solvent medium, the semi-permeable plasma membrane and the relatively high concentration of solutes in the cell sap. The resistance of the cell wall withstands the internal pressure. To find just what solutes are retained by the protoplasmic layer and are thus responsible for the turgor pressure has been the object of much indecisive experimentation. It seems most likely that both organic and inorganic substances function in the different plants though sugar is commonly the cause for the greater part of the pressure. The lack of water about the cell prevents the osmotic action and results in loss of turgidity.

Summary

Data has been collected concerning the teaching of osmosis and diffusion and their functions as forces in plant nutrition. There appears to be some difference of opinion as to the advisability of presenting osmosis as a phenomenon at all different from diffusion and much confusion in assigning to each its correct function in the entry and transmission of water and salts in land plants. The consideration of the problem concludes with an outline for teaching the student of botany the essential facts concerning the two processes and their functions in the handling of food materials, making osmosis to act by reason of diffusion and to move water while simple diffusion moves the solutes.

BELGIAN UNIVERSITY SPECIALIZES IN COLONIAL SUBJECTS.

To train Belgian young men for service in the Congo as physicians. technical men, and administrative officers, a "colonial university" has been established at Antwerp by the Belgian Government. This university has been developed through the successful work of a high school of commerce which was founded two years ago by the Government with the assistance of the Commission for Relief in Belgium and the city of Antwerp, to train boys for colonial service. This school was converted into a university last November and it is now known as "l'Université Coloniale." It has three schools, devoted respectively to political and administrative science, tropical medicine, and natural sciences —[*School Life.*

DOES THE "CHARGE" OF A CONDENSER RESIDE IN THE DIELECTRIC?

By Prof. Harvey C. Roys,

University of Oklahoma, Norman, Oklahoma

In 1751 Benjamin Franklin was doing many interesting things with electricity. One of his experiments made use of a Leyden jar which had movable coatings. The apparatus as made today consists of a tapering glass vessel (Fig. 1) which fits into a tapering metal cup (Fig. 2) and has another tapering metal cup (Fig. 3) that fits inside the glass vessel. When put together (Fig. 4) the metal cups lack about an inch of being
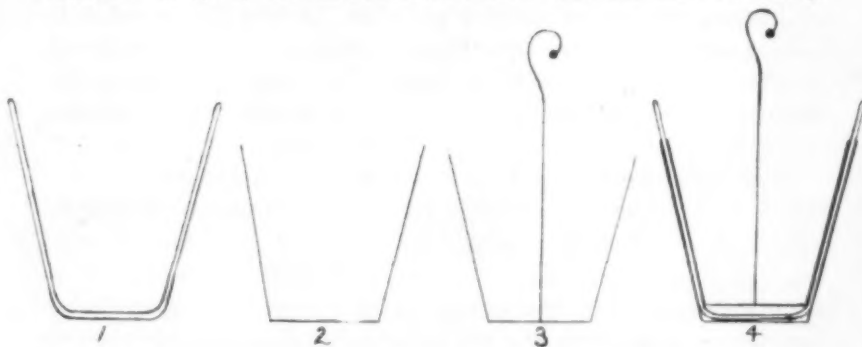
as high as the glass. The inner cup has a metal rod running from the bottom to several inches above the level of the glass and terminating in a hook so it can be lifted out of the glass by a non-conducting rod. Franklin charged the jar and then proceeded to take it apart, using insulators in the process. After the parts were separated, he showed that the metal coatings had no charge, or very little. He touched them together and handled them showing there could be no charge left on them. Then he put the parts together again using an insulator and on connecting the coatings with a discharging rod, he got a discharge.

Franklin explained this phenomenon by saying that the "charge" resided within the glass. The conductors were only carriers and distributors of the charge. When these conductors were removed, the charge stayed within the glass, but when they were put back in place, the Leyden jar was again ready to be discharged. This explanation has persisted in our text books right up to 1922, although for a good many years the theory of the action of a dielectric has contradicted this explanation. As long ago as when Faraday and Maxwell were studying condensers it was thought that the electric charge was stored in

the conductors and not in the dielectric. Then what could be the explanation of Franklin's experiment?

In the March, 1922, number of the London, Edinburgh and Dublin Philosophical Magazine and Journal of Science there appeared a paper explaining this phenomenon. The paper was written by G. L. Addenbrooke and entitled: "A Study of Franklin's Experiment on the Leyden Jar with Movable Coatings." In his study of this experiment, Addenbrooke found that the experiment did not work when the dielectric was made of other substances than glass. He also found, that by putting the apparatus with the glass jar in a drying cabinet for several hours, the experiment would not work. Thus he showed conclusively that the experiment would work only when there was a coating of moisture over the surface of the dielectric.

Glass is hygroscopic, that is, a film of moisture forms over the surface which cannot be wiped off. This film of moisture forms the conducting surface necessary to hold the charge when the metal coatings are removed. The film has such a high resistance that the charge does not quickly flow along its surface. As the inner electrode is lifted out, the potential increases rapidly so that any charge on it tends to flow back to the moisture film at the last point of contact. Another way to explain this would be to say that the opposite charges attract each other and are drawn as close together as possible, thus they are drawn from the metal coatings onto the moisture films. The same is true when the glass is lifted out of the other coating.

Most of the scientific companies dealing in physics apparatus offer this type of Leyden Jar. The description given in the catalogs usually reads something like the following: "Demonstration Leyden Jar for demonstrating that an electrical charge resides as potential energy in the glass of a Leyden jar and not in the metallic coatings." But the scientific companies are only supplying what our text books suggest and using the explanations usually given as a part of the description of the apparatus. We must go to the text books to correct the mistake. Of the high school and college texts edited previous to 1922 and examined for this experiment all that mention the experiment give the incorrect explanation. One suggested the possibility of a moisture film. I have found only one book edited since 1922 that mentions the experiment. Kimball's College Physics, Revised 1923, gives the experiment with the correct explanation.

Addenbrooke suggests that teachers continue to use the experiment and give the correct explanations. We might add to our equipment a hard rubber vessel similar in shape to the glass and show that the experiment works only with glass or a hygroscopic substance. Or we might keep the glass vessel in a drying cabinet for several hours preceding the experiment and then show that the experiment will not work when the glass is dry. This should certainly be the method to follow if we are to continue giving the experiment but there are many who think the experiment ought not to be tried. The experiment, as we now see, adds nothing to our knowledge of dielectrics or of condensers. It merely shows up a peculiar characteristic of glass. If the text books now in use mention the experiment the proper explanation ought to be given, or it should not be brought up at all.

Franklin gave us his theory in good faith. He worked under conditions favorable to the experiment, i. e. he used a glass jar with water for the inner coating and his hand or a metal plate for the outer coating. The tapered jar with metal coatings is a later improvement. If Franklin had worked this experiment with the latter form of apparatus at a time when the relative humidity was very low he probably would never have discovered the peculiarity. I have tried this experiment under such conditions and have been unable to get Franklin's results.

THE THREE STEP METHOD OF TEACHING GEOMETRY.

By FLORENCE L. ABBOTT

Hyde Park High School, Chicago

A teacher of geometry is beset with various difficulties. Some students fail because of their apparent inability to reason; others of fair ability occasionally back up their conclusions by quoting propositions that haven't a thing in the world to do with the point in question; and still others fail to observe that they have not as yet proved the facts necessary to make a given proposition applicable to the case in hand. In the first instance the pupil is utterly unable to reason when using mathematical material; in the second he is none too certain to do it, and in the last case he has not acquired the habit of scrutinizing his available material. Is there any method of teaching geometry which will overcome either wholly or in part these difficulties? I claim there is.

In the three step method the pupil is taught at the very beginning of the course, while he is acquiring certain geometrical concepts, the three steps necessary in all deductive reasoning. In order to give him confidence and to avoid increasing his difficulties by teaching him the steps involved in the new field of geometry, he is taught to reason, consciously, in very simple matters in the realm of everyday life. He does not use the terms of logic to describe his first two steps, but he does label them during the first few weeks of his geometrical career for that enables him to keep his bearings. Probably the terms "known fact" and "general principle" are as good as any to describe these steps.

These simple exercises are of the following type: Required to prove that this geometry class has a teacher.

Known Fact—This is a geometry class.

General Principle—All geometry classes have teachers.

Conclusion—This geometry class has a teacher.

In the midst of this attempt the ability to pick out the hypothesis and the desired conclusion is acquired and the distinction between an abstract principle and a concrete fact usually arises. Occasionally in the first few days some individual will be found in this sort of work who repeatedly fails to see the necessary conclusion when the other two steps have been given. In this day of intelligence tests this constitutes a simple and crucial test of the pupil's ability to reason. If he is entirely lacking in this ability, it is very evident that he is not going to be able to do geometry at least at his stage of development. As this is discovered in the first few days of the course, it is not too late for him to go into some other course.

After a few days, the pupil having acquired certain geometrical concepts and having learned to take the three steps involved in deductive reasoning, is quite ready to attempt them in geometry.

Now why is this method better than the usual one which assumes the ability of the student to reason in geometrical material? Isn't one of the reasons for teaching geometry supposed to be that it teaches the pupil to reason? If that is so are we justified in assuming that he can do so at the beginning of the subject? Some students under the usual method fail to reason, not because of total lack of ability, but merely because, in the confusion arising from a new subject, they fail to do it automatically and have to be shown how.

Secondly in the usual method of presentation some students do not readily see that the proof of a proposition consists in

reasoning. I have seen them in the study hall write out completely the various conclusions to be reached in proving a certain pair of homologous parts of congruent triangles equal, without writing down a single reason; but realizing that their teacher would expect them to fill in that blank they appealed to me for the reasons, having completely failed to grasp that the conclusion is only reached as the result of the application of a general principle to certain definite known facts.

In this new method of teaching geometry inasmuch as the pupil is required to write out the first step and apply his general principle, in case he lacks the facts necessary to apply the desired principle he notices it at once and proceeds to prove those facts; and as he is accustomed to see that the principle he quotes is applicable to the case in hand, he isn't given to quoting just anything that occurs to him.

As to some difficulties or dangers of this method, just as a person who lays undue emphasis upon his ancestry is very likely not to get any place himself, so the pupil who is merely trying to find a principle applicable to the known facts is very likely to be traveling in a circle. He must be taught early the necessity of forming a scheme by which he hopes to accomplish the desired end before he ever starts his proof, and not expect to run across his conclusion by chance in the course of his wanderings.

The complete statement of the first step takes time and does not make for compactness of form; but as the pupil acquires ability and convinces the teacher of it, he may gradually omit or abbreviate in the written proof the statement of his first step and should, in time, be encouraged to do so.

It is evident that this method could easily be overdone and too much logic be introduced into the geometry. In my opinion only the merest intimation, as suggested, should be given, just enough to give the pupil an idea as to how to go at a proof, being sure to avoid making the subject abstract and consequently dull and dry to the sophomore. In this method he understands from the beginning something of the reasons for studying geometry. He is interested in testing his ability to reason and he likes it from the first because he has been so taught that he knows or thinks he knows how to prove, as soon as he is asked to do so in geometry.

This method may seem too abstract and dull for the average high school sophomore. My only answer to that is, try it and see.

GRAPHICAL METHODS AND LINES OF FORCE.

By R. C. COLWELL,

West Virginia University, Morgantown, W. Va.

The lines of forces from a single electric charge e are represented by straight lines radiating from the charge. If another charge $-e$ is placed in the field, its lines of force which are also straight

Figure I
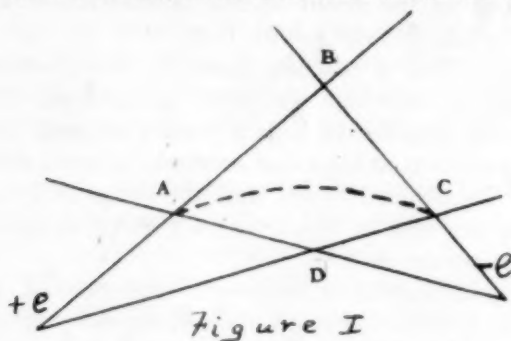
lines will cut across the lines of the first charge and form a number of irregular quadrilaterals such as A B C D. If now a unit positive charge is placed at A it will be repelled by the charge e in the direction AB. At the same time the tube AB, since it contains a positive charge, will be attracted toward $-e$.

—— LINES OF FORCE ——
TWO EQUAL OPPOSITE CHARGES
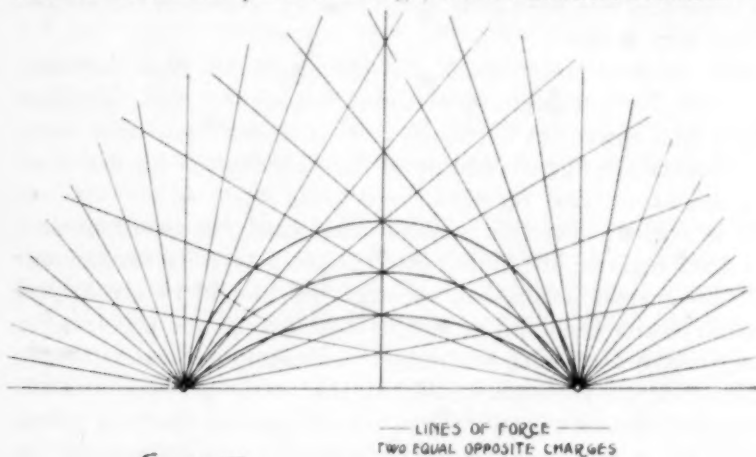
Figure II

The combined motion of the charge along AB and of AB toward $-e$ will make the unit charge travel along a curved path from A to C as indicated by the dotted line. The dotted line AC is therefore a portion of a line of force of the field due to both e and $-e$. When a great number of quadrilaterals are formed

the lines of force may be found by joining the opposite angles of the quadrilaterals in succession. This has been done for two equal charges alike and unlike (Figures 2 and 3). The field of

Figure III
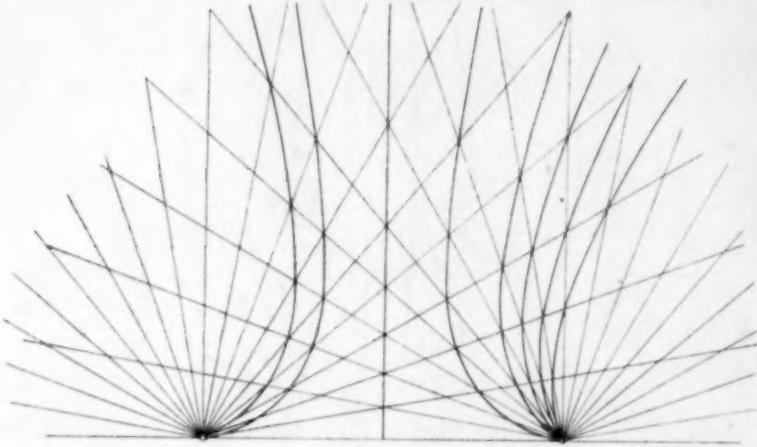
—LINES OF FORCE—
TWO EQUAL LIKE CHARGES

figure (3) may be combined with another charge $-e$ forming a triangle with the first two. Thus the field of Figure 4 has been drawn.
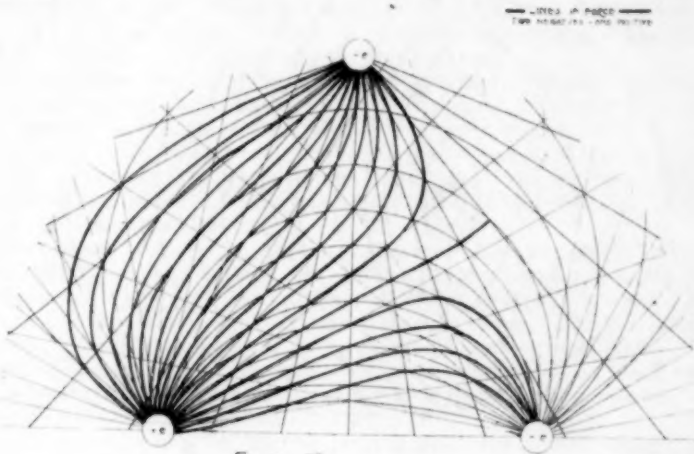
Figure IV

Again the equation

$$\frac{x^2}{a^2+k} + \frac{y^2}{b^2+k} + \frac{z^2}{c^2+k} = 1$$

represents a family of ellipsoids and the equation

$$\frac{x^2}{a^2+k} - \frac{y^2}{b^2+k} - \frac{z^2}{c^2+k} = 1$$

represents a family of hyperboloids which cut the ellipses at
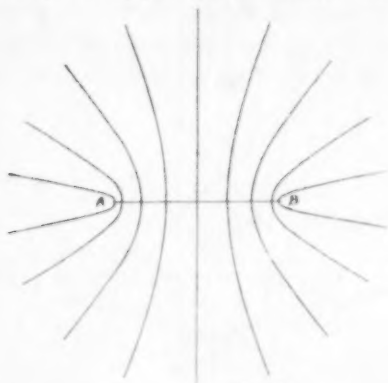
Figure V

right angles. Now the lines of force must leave the surface of a conductor at right angles so that a thin ellipsoid with hyperboloids drawn through it may be taken to represent a charged rod with its lines of force. Figure 5. A charged horizontal

Figure VII
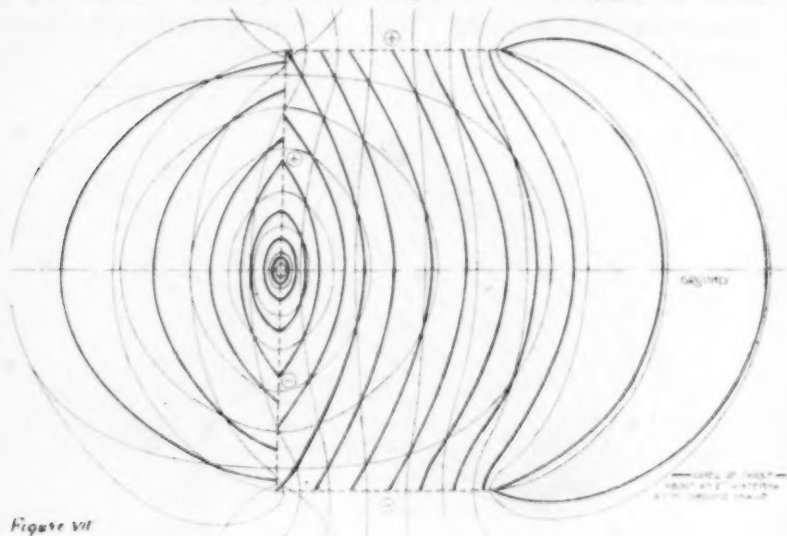
antenna such as is used in wireless telegraphy will then have lines of force approximately as shown in Figure 5. However such an antenna will have an image in the earth and the two fields may be combined as in the case of point charges. Such a combination is shown in Figure 6.
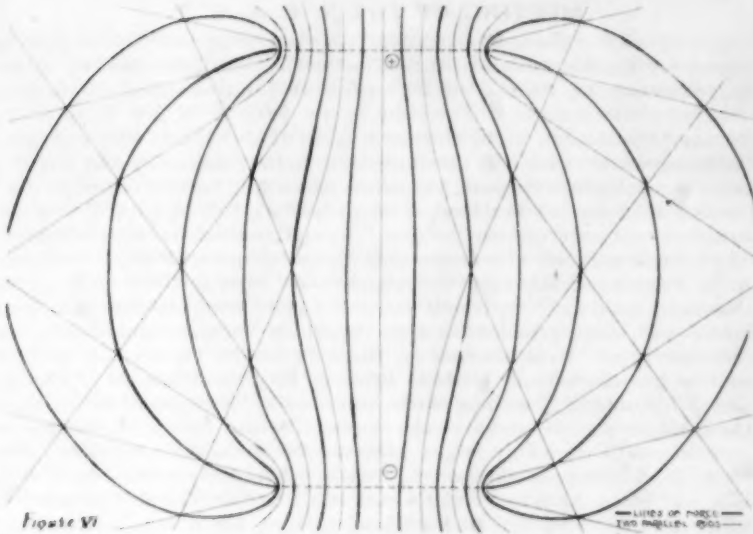
Figure VI

The field of force about an antenna consisting of horizontal and vertical parts is shown in Figure 7.

HERE ARE WILD FLOWERS YOU MAY GATHER FREELY.

Daisies and buttercups are still fair game for the automioble wild flower hunter. No closed season has been declared on them by the Wild Flower Preservation Society which has determined what wild flowers may or may not be freely picked without danger of extermination. The list of flowers which may be picked at any time is large.

The common field daisy is on the list, together with such other farn weeds as the wild carrot and the wild mustard. No amount of picking can destroy them apparently. Buttercups are included, as is another old favorite, "butter and eggs." Black-eyed Susans or "Ox-eye daisies" are also non-exempt, as are clover and dandelions. The dandelion home-brew crop is apparently forever assured in spite of the increased demand resulting from prohibition.

Wild asters of all sorts, evening primroses and everlastings may be gathered at will, and so may the stiffer and more formal boneset, wild sunflower and joe-pye weed. Goldenrod is fair game at all times. The list may be extended to include arrow head, bindwee, California poppy, chicory, cinquefoil, dogbane, ground ivy, Japanese honeysuckle, the lupine of the western plains, milkweed, wild morning glory, poke weed, St. John's wort, touch-me-not, trumpet creeper, wild lilac, yarrow, and a number of lesser known wild flowers.

All of these are allowed for free picking by lovers of wild flowers, and their variety assures the possibility of an artistic bouquet at all seasons. So the picnickers are counseled by the Wild Flower Preservation Society to leave the dogwood and arbutus alone with many other delicate flowers of the woods and fields, to be chary of picking blue flag and galax and hepatica. If they must pick flowers, they should stick to the tough and enduring ones first mentioned. There will always be enough daisies, buttercups, and goldenrod to go around.—[*Science Service*.

MEETING OF THE N. E. A. C. T.

A very well attended meeting of the New England Association of Chemistry Teachers was held at the Boston English High School on Saturday, February 14, 1925. President Leslie O. Johnson called the meeting to order at 10:00 a. m. and introduced Mr. Fred R. Miller, Head of the Science Department of the Boston English High School, who welcomed the members and friends of the association to the first established physical and chemical laboratories in any secondary school in this country. Mr. Charles H. Stone of the Boston English High School gave a very instructive and entertaining talk on "Some Experiments with Nitrates" which he illustrated with many well chosen demonstrations. Professor A. L. Pouleur of Wheaton College showed "Models Used in Teaching Organic Chemistry" and built up some more complex formulae from atoms and simpler molecules represented by various colored balls and different types of attachments. Mr. Walter F. Downey announced courses for teachers in General Science, Physics, Chemistry, Biology and Mathematics Teaching with round table discussions on teaching these subjects to be given at the Summer School of the Massachusetts Institute of Technology where splendid facilities are available. Professor L. A. Olney of the Lowell Textile School gave a very interesting talk on "Some Applications of Chemistry" to the Textile Industry in which he told of natural and artificial textiles, the dyeing and finishing of these. He mentioned that artificial silk may soon replace the natural because it wears longer and better. He is unable to supply enough good young men for positions which generally pay at least $5,000.00 within four years out of the textile school.

President Johnson announced the following meetings for 1925: March 14 at Brown University; May 2 at the New Hampshire State University; May 16 at the Mt. Hermon School; Nov. 14 at Wheaton College; and Dec. 5 at Bridgeport, Conn., to be a joint meeting with the Chemistry Teachers. Association of New York. Division Chairman Ricker of the Woburn High School tried out a cross word puzzle, awarded prizes, and took charge of the business meeting where new books and material of interest to teachers of chemistry were shown and discussed. "The Fountain of Youth" and two sport reels were shown in motion picture by courtesy of the Chelmsford Co., after which the laboratories were inspected.

JOHN H. CARD, SEC.

OIL IN SOUTHERN CALIFORNIA.

Government Report on an Erea in Los Angeles and Ventura Counties.

Illuminating oil was distilled from petroleum obtained from a seepage in southern California as early as 1856 and used in lamps, and in 1860 this region, in our day so thoroughly advertised, was said to contain underground "rivers of oil" that could be carried to all the ports of the Pacific coast through pipe lines. This pipe dream of the sixties found partial realization later, as may be seen by the fact that more than a billion barrels of oil has since been piped from wells in that region to Pacific ports.

In Los Angeles and Ventura counties many wells were drilled between 1880 and 1900, and then the output there and the interest in oil diminished. During the last few years, however, the rise in the price of crude oil has caused a renewal of activity in the oil fields in this region, and some new territory has been developed, not in the old haphazard way but by application of modern geologic principles. A member of the Geological

Survey, Department of the Interior, surveyed the valley of Santa Clara River long ago, and another member, W. S. W. Kew, has recently surveyed what is called the Ventura-Newhall district, an area northwest of Los Angeles, and prepared a report on it. This report, which has just been published in the Geological Survey's Bulletin 753, covers parts of west-central Los Angeles and southeastern Ventura counties, which embrace the oldest as well as some of the new fields of California. Among the producing districts in this area are the South Mountain, Shiells Canyon, and Bardsdale fields.

Geologists working in southern California should find this report very useful, for it contains much valuable information regarding the distribution of the several formations, their correlation with those in other districts, and their relation to oil generation and production. For the benefit of the operators and practical oil men the scientific discussions in the text are supplemented by maps showing the distribution of the geologic formations and the locations of the anticlinal axes. The areas that appear favorable are pointed out, and those that are apparently unfavorable are indicated with equal candor. The positions of the producing fields are shown on the maps, as well as the positions of such dry holes as were found during the field work.

[*Department of the Interior.*]

NEW GOVERNMENT MAPS OF AREA NEAR THE ALASKA RAILROAD

The Department of the Interior announces the issue of the last two sheets of a three-sheet map covering the area tributary to the Alaska Railroad, between the towns of Seward and Fairbanks. These sheets are the result of field mapping by the Geological Survey. The first or southernmost sheet—"Seward to Matanuska Coal Field"—was published by the Geological Survey in June, 1924; the second sheet is entitled "Matanuska Coal Field to Yanert Fork;" and the third or northern sheet, "Yanert Fork to Fairbanks."

These three sheets, published on a scale of 1:250,000 or 4 miles to 1 inch, may be mounted as a single map, 9 feet long and 3 feet wide, showing the Alaska Railroad in its entirety and the neighboring country. Within this region, having an area of 60,000 square miles, lie parts of three great mountain ranges, a multitude of glaciers, and a considerable portion of the Mount McKinley National Park. Mining districts producing copper, coal, silver, and both lode and placer gold are included within its boundaries, as well as some of the most promising agricultural land in the Territory. The area shown on these sheets is destined to become of great economic value to Alaska. They may be obtained from the Geological Survey, Washington, at 50 cents a copy, or $1.50 for the three sheets

THE LOWEST POINT IN UTAH.

No doubt many people, if asked to name the lowest point in Utah, would answer, "Salt Lake," which is the remnant of the great prehistoric Lake Bonneville, a body of fresh water that covered a large area in Utah. The lowest point, however, is not Salt Lake but Beaverdam Creek, in Washington County, which is 2,000 feet above sea level, according to the Department of the Interior, Geological Survey. Utah has an approximate mean elevation of 6,100 feet, which is exceeded only by that of Colorado, 6,800 feet, and Wyoming, 6,700. The highest point whose elevation has been exactly determined is Kings Peak, in Wasatch County, which is 13,498 feet above sea level.

PROBLEM DEPARTMENT.

Conducted by J. A. Nyberg,
Hyde Park High School, Chicago.

This department aims to provide problems of varying degrees of difficulty which will interest anyone engaged in the study of mathematics.

All readers are invited to propose problems and solve problems here proposed. Problems and solutions will be credited to their authors. Each solution, or proposed problem, sent to the Editor should have the author's name introducing the problem or solution as on the following pages.

The Editor of the department desires to serve its readers by making it interesting and helpful to them. Address suggestions and problems to J. A. Nyberg, Hyde Park High School, Chicago.

LATE SOLUTIONS.

848. *V. Livarama Krishuan, Pudukotah, India.*
857. *T. Dantowitz, Kensington H. S., Philadelphia.*
860. *F. Buckmaster, Redlands H. S., Calif.*

SOLUTIONS OF PROBLEMS.

The following solution of problem 853 is more elementary than the solution in the February issue.

853. *Proposed by J. F. Howard, San Antonio, Texas.*

Find the sum of all the products of the first n integers taken three at a time.

Solved by J. T. Crawford, Ontario College of Education, Toronto.

Let the integers be $a, b, c, .$. It has been shown that
$$6(abc \ldots) = (a+b+c+\ldots)^3 + 2(a^3+b^3+\ldots)-$$
$$3(a+b+\ldots)(a^2+b^2+\ldots)$$

When $a, b, c,$ are successive integers, we know that
$\xi a = n(n+1)/2.$ ....$a^2 = n(n+1)(2n+1)/6$ and
$\xi a^3 = n^2(n+1)^2/4.$

Substituting these values in the above identity,
$$\xi abc = n^2(n+1)^2(n-1)(n-2)/48.$$

861. *Proposed by the Editor.*

Find a formula for telling in what particular month and year any given problem, as number 546 for example, was solved in this department (five problems are solved each month excluding July, August, and September).

I. *Solved by N. H. Mewaldt, State Normal School, Dickinson, N. D.*

Expressed in words the rule is:

Add 9 to the number of the problem; divide by 5, and disregard the remainder; divide by 9. Adding the quotient to 1906 gives the year; the remainder states the month if we count January as the zeroth month, February the first, June the fifth, etc., and December the eighth month.

II. *Solved by Raymond F. Schnepp, Chaminade College, Clayton, Mo.*

Since the solutions appear 5 at a time, we may treat any number, say 546, as the next higher multiple of 5, i. e., as 550, because this problem appeared the same month as 546. Dividing this multiple 5 of by 5 gives a result which is equal to the number of issues of the magazine that have appeared since Feb., 1906. The latter date is $(6 \times 9) +2$, or 56, issues from January 1900. If therefore to our previous result we add the 56, we shall have the number of issues since Jan., 1900. If this sum is divided by 9 the quotient will be the year of the century and the remainder will be the month, counting June as 6 and October as 7, etc.

The formula would be: $(N/5+56)/9$ where N is not the number of the problem but the next higher multiple of 5.

Thus, for problem 546, we have $N = 550.$ $N/5 = 110.$ $110+56 = 166.$ $166/9 = 18$ and $4/9.$ Hence the year is 1918, and the month April.

If the last quotient is an integer, as 17 for example, it must be considered as 16 and 9/9; the year 1916, and the month of December.

Also solved by *J. Murray Barbour, Ardmore, Pa., F. A. Cadwell, St. Paul, Minn.*

862. *Proposed by Philomathe, Montreal, Canada.*
By the compass alone find the mid-point of a line segment.
Solved by F. A. Cadwell, St. Paul, Minn.

Let AB be the line segment. With A and B as centers and AB as radius describe two circles intersecting at C and D. With C as a center and CD as a radius, draw an arc intersecting circle B at E. With E as a center and EB as a radius, draw an arc intersecting circle B at F and G. With F and G as centers and FB as a radius, draw arcs intersecting at H.

Then H is the mid-point of AB.
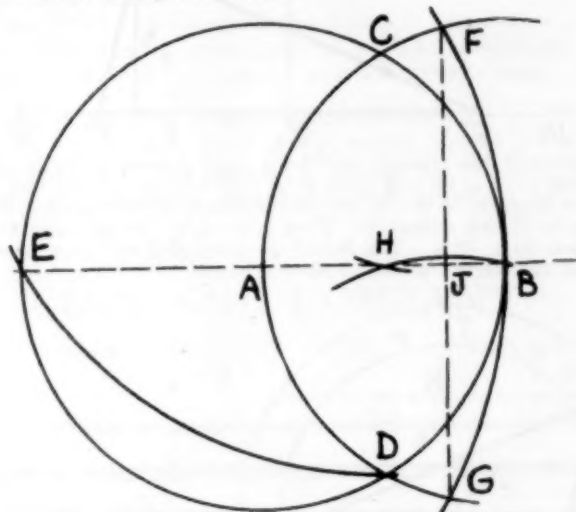
Proof: BC and BD, being chords of circle A equal to its radius, each subtend an arc of 60°. Therefore CD subtends an arc of 120°; hence the arc EB = 180°, or E, A, and B are collinear and EAB is the diameter of circle A. Also FG is the common chord of the circle B and the circle whose center is E. Therefore FG is perpendicular to EB and is bisected by EB. G is equi-distant from F and H by construction, and hence must lie in the line AB.

Call J the intersection point of EB and FG.

Then BJ is the altitude of △BFG upon FG. Also, the diameter of the circle E is 4AB. Therefore BF × BG = BJ × 4AB. (The product of two sides of an inscribed triangle equals (the product of the altitude on the third side and the diameter of the circle). Since BF and BG are each equal to AB, we have BF × BG = AB². Hence AB² = BJ × 4AB, or AB = 4BJ

Since △FBH is isosceles, FJ bisects HB, or BH = 2BJ.

Therefore AB = 2BH, or H is the mid-point of AB.

Also solved by *Michael Goldberg, Philadelphia, Pa.; S. H. Parsons, Paris, Ontario; Raymond F. Schnepp; and George Sergent, Guatemala, C. A. F. A. Cadwell* also gave a second solution, based on the method in problem 656. Several solutions were incorrect in that they assumed that it was permissable to draw a circle *touching* another circle or a line. This can not be done without first finding the point of tangency.

863. *Proposed by Nelson L. Roray, Metuchen, N. J.*
Given 2s, c, and h_c, construct the triangle.

I. *Solved by Irma L. Smalley, Ogdensburg, N. Y.*
Take FF' = c, and let O be the mid-point of FF'. Take ON = OM = ½(2s − c) = ½(d + e) where d and e are the two sides of the triangle to be found.

Then the vertex of the triangle will be on the ellipse whose foci are F and F', and whose major axis is $(d+e)$ or MN, and whose minor axis is found by taking F as a center and OM as a radius and describing an arc cutting the perpendicular to MN at O; the minor axis is twice OP.

The equation of the ellipse is $x^2/a^2 + y^2/b^2 = 1$, where OP $= b$.

The vertex of the triangle will be a point whose ordinate equals h_e. Substituting h for y, we can write $x^2/a^2 = (b^2 - h^2)/b^2$. Construct a square whose area is equal to $b^2 - h^2$, or the difference of the squares, b^2 and h^2. Call the side of this square k. Then $x/a = k/b$. Hence, find the fourth proportional to a, k, b. The fourth proportional will give us x, or the abscissa of the vertex of the desired triangle.

II. *Solved by Garfield M. Weld, Taft School, Watertown, Conn.*

Suppose AL $= 2s$, and AB $= c$; then BL $= 2s - c$. If OK $= h$, then the locus of C is a line parallel to AB through K, as KN. If CA + CB is to be equal to BL, which is a constant, the locus of C is an ellipse with A and B as foci and BL equal to the major axis. The position of C is therefore the intersection of these loci.

The intersection of the loci can be found by using the usual two auxiliary circles of the ellipse. The radius, OS, of the major circles is ½BL. The radius of the minor auxiliary circle is OT which is found by using B as a center and ½BL as a radius and drawing an arc intersecting the perpendicular through O, the mid-point of AB.

Let the line KN intersect the minor circle at P. Draw OP and extend it to cut the major circle at Q. The usual construction for an ellipse then consists in drawing a horizontal line through P and a vertical line through Q, their intersection point C being then a point on the ellipse. Since C is a point on the ellipse and also a point on MN, it is the desired vertex of the triangle.

III. *Solved by George Sergent, Guatemala, C. A.*

Analysis. The formulas for the area of a triangle provide the equation $rs = \frac{1}{2}ch_e$, whence $s/c = \frac{1}{2}h/r$ where r is the radius of the in-circle, and is in this case the fourth proportional to three known lines.

The distance between the points of contact, D and E, of the in-circle, O, and one of the escribed circles, O', equals c; and the distance from the vertex C to E equals s.

Construction. Take DF $= s$; and on the same line lay off DE $= c$. Draw DG $\perp$ DF, and equal to ½h. The parallel through E to FG deter-

mines the center, O, and the radius DO of the in-circle. On FD produced lay off $EC = s$. Then CO produced determines the center and radius of the escribed circle, on the perpendicular at E to CE. Draw the second exterior tangent to the circles O and O'. Any one of the two interior tangents to the same circles determines the vertices A and B on the exterior tangents. ABC is the required triangle.
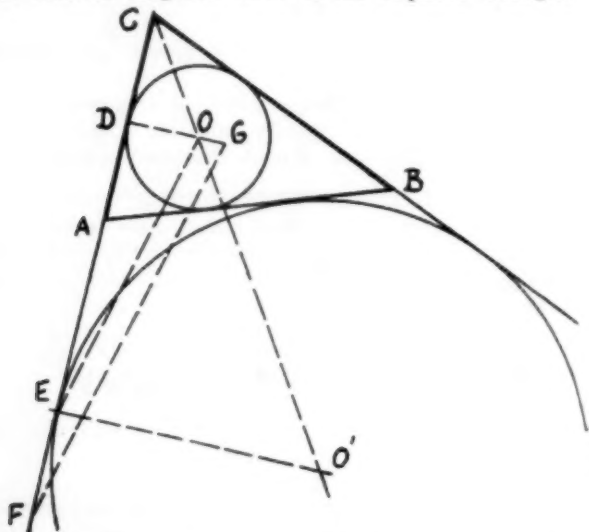
We should now prove that $AB = c$, but all the data having been used according to well known formulas, the proof is obvious.

Also solved by *F. A. Cadwell* (two solutions); *L. Carlitz, Philadelphia, Pa.; T. Dantovitz, Philadelphia, Pa.; Michael Goldberg; C. L. Hunley, Redlands, Cal.; N. H. Mewaldt; S. H. Parsons; Philomathe;* and *Raymond F. Schnepp.*

864. Proposed by *Michael Goldberg, Philadelphia, Pa.*

Prove that $\operatorname{cosec} 10° + \operatorname{cosec} 50° - \operatorname{cosec} 70° = 6$.

I.   Solved by *Ernest McGrath, '25, Oak Park H. S., Ill.*

$$\csc 50° + \csc 10° - \csc 70° = \frac{1}{\sin 50} + \frac{1}{\sin(60-50)} - \frac{1}{\sin(120-50)}$$

$$= \frac{1}{\sin 50} + \frac{1}{\sin 60 \cos 50 - \cos 60 \sin 50} - \frac{1}{\sin 120 \cos 50 - \cos 120 \sin 50}$$

$$= \frac{1}{\sin 50} + \frac{1}{\frac{1}{2}\sqrt{3}\cos 50 - \frac{1}{2}\sin 50} - \frac{1}{\frac{1}{2}\sqrt{3}\cos 50 + \frac{1}{2}\sin 50}$$

$$= \frac{1}{\sin 50} + \frac{4\sin 50}{3\cos^2 50 - \sin^2 50}$$

$$= \frac{1}{\sin 50} + \frac{4\sin 50}{3 - 4\sin^2 50} = \frac{3 - 4\sin^2 50 + 4\sin^2 50}{3\sin 50 - 4\sin^3 50}$$

$$= \frac{3}{\sin 150} = \frac{3}{\sin 30} = 6.$$

II.   Solved by the *Proposer.*

The solutions of the equation $\cos 9x - 1 = 0$ are

$x = 0, \pm 2/9\pi, \pm 4/9\pi, \pm 6/9\pi, \pm 8/9\pi.$

Expanding $\cos 9x$, the equation is

$$256\cos^9 x - 576\cos^7 x + 432\cos^5 x - 120\cos^3 x + 9\cos x - 1 = 0.$$

From the exponents in this equation we see that the sum of the products of the roots taken 8 at a time divided by the product of the nine roots is equal to the sum of the product of the reciprocals of the roots. Hence

$$\frac{1}{\cos0}+2\left(\frac{1}{\cos2/9\pi}+\frac{1}{\cos4/9\pi}+\frac{1}{\cos6/9\pi}+\frac{1}{\cos8/9\pi}\right)=9$$

By substituting the numerical values for cos0 and cos150, and changing to the supplements of the angles, the required result is found.

Also solved by *Sudler Bamberger, Harrisburg, Pa.; J. Murray Barbour; L. Carlitz; C. Hitchcock, '25, Taft School, Watertown, Conn.; R. T. Mc-Gregor, Elk Grove, Cal.; N. H. Mewaldt; David S. Milne, Dickinson H. S. Jersey City, N. J.; A. Nicolson, San Jose, Cal.; Philomathe; Charles Roede, Dickinson H. S., Jersey City; Henry Ruzicki, St. Martin's College, Lacey, Wash.; Raymond F. Schnepp; George Sergent; and Garfield Weld.*

865.   *For High School Pupils. Proposed by I. N. Warner, State Normal School, Platteville, Wisconsin.*

A, working upon a certain task, can do it alone in 15 days; B requires 18 days alone, C, 21 days, and D, 24 days. Later on these same four men work together upon a job agreeing to accept payment according to their working rates. The total pay is $79.95. How shall the money be divided among the four men?

Solved by Georgianna Page, Bowling Green H. S., Kentucky.

We know that A can do the same work in 15 days that it takes B 18 days, C 21 days, and D 24 days. When all four men work together, A would do the most work. Therefore he would receive the largest part of the money.

B would do 15/18 or 5/6 as much work as A; C would do 15/21 or 5/7 as much as A; and D would do 15/24 or 5/8 as much as A could do.

Let x = no. dollars A receives.

$5x/6$ = no. dollars B receives.

$5x/7$ = no. dollars C receives.

$5x/8$ = no. dollars D receives.

Their sum, $x+5x/6+5x/7+5x/8$ = no. dollars all receive.

$$x+5x/6+5x/7+5x/8=79.95$$

(Solution of equation omitted here, by the editor)

x = $25.20 no. of dollars A receives.

$5x/6$ = $21.00 no. of dollars B receives.

$5x/7$ = $18.00 no. of dollars C receives.

$5x/8$ = $15.75 no. of dollars D receives.

The same method of solution was used by *Paul Reser, Carthage, Mo.;* and *Russell Huckaby, Frances Mikel, Harold Ward of Redlands H. S., Cal.* The other solutions were arithmetical or were based on the equation $x/15+x/18+$etc. There is no objection to an arithmetical solution except that it requires more explanation to justify the various steps. The correct arithmetical work is frequently given but there is seldom any explanation of why certain operations are performed. Two (incorrect) solutions awarded the pay according to the number of days in which each man could do the work alone, so that the slowest man received the most pay.

Also solved by

Dickinson H. S., Jersey City, Sylvia Epstein.

East Orange, New Jersey, Robert H. Stevens.

Kensington H. S., Philadelphia, Tille Dantovitz.

North East H. S., Kansas City, Mo., Mildred Day.

Normal H. S., Dickinson, N. D., Marlys Hegge; Ruth Hickle.

Petersburg H. S., Alaska, Henry Adsere; Mildred Cornstad; Alma Cornstad; Anita Allen; Clara Martinsen; Magnus Martens; Hedwig Mjorud; Annie Mathisen; Minnie Nelson; Ruby Rayner (who gave the best arithmetic solution); Harold Shields.

Redlands H. S., Cal., George Beattie; Vera Bruner; Harold Hobbs; Grace Oosterheert; Carey Thompson.

Taft School, Watertown, Conn., Curtis Hitchcock.

Visitation H. S., Chicago, Catherine McGovern.

PROBLEMS FOR SOLUTION.

876   *Proposed by Nelson L. Roray, Metuchen, N. J.*

Given $2s$, c, and h_c. Solve the triangle; that is, derive formulas for the unknown parts. (The construction of the triangle is discussed in problem 863.)

877.   *Proposed by R. T. McGregor, Elk Grove, Cal.*

Sum to infinity the series $2/3 + 4/5 + 6/7 + 8/9 + \ldots \ldots$

878.   *Proposed by George Sergent, Guatemala, Central America.*

Prove that in any triangle $\tan \tfrac{1}{2}C = (a - b)/(r_a - r_b)$

879.   *Proposed by C. E. Githens, Wheeling, W. Va.*

Given a circle and its center. By means of the compass alone, find the vertices of the inscribed pentagon.

880.   *For High School Pupils. Proposed by L. E. Lunn, Heron Lake, Minn.*

If the interior and exterior angles at both A and B of $\triangle ABC$ be bisected, prove: The angle between the interior bisector of A and the exterior bisector of B equals the angle between the interior bisector of B and the exterior bisector of A.

BOOKS RECEIVED.

Fifty Famous Farmers, by Lester S. Ivins, State Supervisor of Agriculture, Ohio, and A. E. Winship, Editor of Journal of Education. Pages xiv 407. 14x20.50 cn. Cloth, 1925. Macmillan Co., New York City.

Practical Methods in Microscopy, by Charles H. Clark, Philips Executor Academy. Pages xxviii 337. 13.50x19 cn. Cloth, 1925. D. C. Heath & Co., Chicago.

Calculus of Variations, by Gilbert A. Bliss, University of Chicago. Pages xiii 189. 13x19 cn. Cloth, 1925. Open Court Publishing Co., Chicago.

Solid Geometry, by J. W. Young, Dartmouth College, and Albert J. Schwartz, Grover Cleveland High School, St. Louis. Pages xvi 399. 13x19 cn. Cloth, 1925. Henry Holt & Co., New York City.

Agricultural Mechanics, by Robert H. Smith, New York School of Agriculture. Pages vii 357. 15x21.50 cn. Cloth, 1925. J. B. Lippincott Co., Chicago.

Statistical methods and applied to economics and business by Frederick C. Mills, Columbia University. Pages xvi plus 604. 15x22 cm. Cloth, 1924. $3.60. Henry Holt & Company, New York City.

Junior Mathematics, Book One, by Earnest R. Breslich, University of Chicago. Pages 16 plus 279. 13x17 cm. Cloth. 1925. Macmillan Company, New York City.

Laboratory Manual of the Foetal Pig, by W. J. Baumgartner, University of Kansas, Manhattan. Pages xii + 57, 13x19½ cm. 1924. Cloth. The Macmillan Company, New York City.

CHEMISTRY AND RECENT PROGRESS IN MEDICINE.

Professor Julius Stieglitz, Chairman of the Department of Chemistry at the University of Chicago, recently gave at Johns Hopkins University a series of lectures on the Charles E. Dohme Memorial Foundation, his general subject being "Chemistry and Recent Progress in Medicine." The lectureship was founded by Mrs. Dohme in memory of her husband, a prominent manufacturer of pharmaceuticals in Baltimore. The first lecturer on the Foundation was the late Dr. H. G. Hamburger, professor of Physiology in the University of Groningen, Holland. The purpose of the lectureship is to promote the advancement and spread of science, and in particular the service of science to the cause of medicine.

Professor Stieglitz, who was recently awarded the Willard Gibbs Medal for important researches in chemistry, has been president of the American Chemical Society and is regarded as one of the leading chemists of the country.

SCIENCE QUESTIONS.
Conducted by Franklin T. Jones.
The White Motor Company, Cleveland, Ohio.

To Readers of School Science and Mathematics:
   You are invited to propose questions for solution or discussion.
   You are asked to answer questions.
   Examination papers are always desired. Send in your own papers or any others. Some are interested in college entrance examinations, others in school or college examinations. All are desired.
   Please address all communications to Franklin T. Jones, 10109 Wilbur Avenue, S. E., Cleveland, Ohio.

QUESTIONS FOR SOLUTION.

461. *By courtesy of The Metric Association, 156 Fifth Ave., New York City.*
   (Additional copies of this puzzle may be obtained at The Metric Assn. at the following rates: 1 for 3c., 10 for 20c., 100 for $1.)
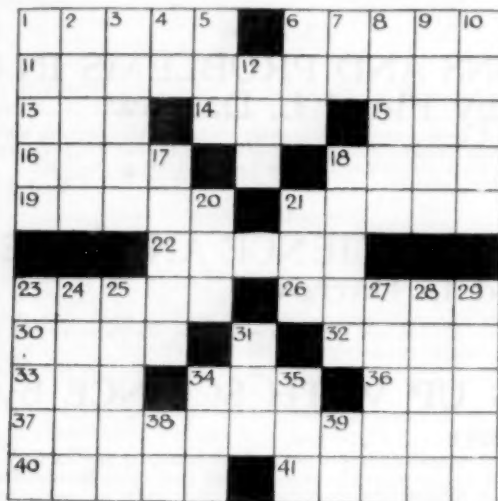
METRIC CROSS WORD PUZZLE NO. 1.
Across

1. Plural of the unit of weight in the metric system.
6. Christmas pie.
11. Plural of the 1000th part of a meter.
13. What we should do with the metric system.
14. A metal.
15. One who goes crazy trying to learn all our present antiquated hodge-podge of weights and measures.
16. First letters of the following groups favoring the general use of the metric system: Nurses, Engineers, Manufacturers, Scientists.
18. Prefix meaning 1000.
19. To draw off water or any liquid.
21. Abbreviation for the Biblical name Baalperazim.
22. Fundamental standard from which metric system is derived.
23. Popular science where wave lengths are given in meters.
26. Synonym for conversed, in phonetic spelling.
30. Any defined extent of plane surface, as the space included in each of these square centimeters.
31. Abbreviation for gram.
32. Part of automobile on which dimensions are marked in millimeters.

33. Abbreviation for National Volunteers of America.
34. A number, the basis of the metric system.
36. Largest metric weight, equal to 1000 kilograms.
37. Plural of the 100th part of a meter.
40. An old yarn measure about 500 meters long.
41. Bad in a greater degree.

Down.

1. Town in Wurtemburg, Germany.
2. One who gets up.
3. Name of a town in ancient Gilead.
4. Abbreviation for milliliter.
5. To take a seat.
6. A primate mammal whose average weight is 70 kilograms.
7. Pronoun.
8. An elegy.
9. Old word meaning curly.
10. Legal term meaning to impede or bar.
12. Article worn by baseball catcher.
17. An ape.
18. Weight, two-tenths of a gram, used by jewelers in weighing previous stones.
20. Prefix meaning "new."
21. Wager.
23. Cattle-farm.
24. District in India.
25. American diplomat who died in 1789, about the time the metric system was formulated.
27. The metric unit of capacity for both liquid and dry measure.
28. A jumble of letters as unrelated as the old weights and measures being replaced by the metric system.
29. Rigid.
31. Precious stone.
34. Abbreviation for "it is."
35. The kind of idea worth investigating.
38. The initials of a famous man who said of the metric system: "We must have it."
39. Preposition.

462. *Borrowed from the mathematicians.*

(Our excuse for publishing this as a *science* problem lies in the *motion* of bee and automobile.)

Two automobiles twenty (20) miles apart are approaching each other, each traveling ten (10) miles per hour. A bee which flies at the rate of fifteen (15) miles per hour starts at the radiator of one automobile and flies back and forth between their radiators until the autos meet.

How far does the bee fly?

(N. B.—This problem can be solved without any mathematics higher than arithmetic. Explain either way.)

EXAMINATION PAPERS.

The teaching professor in the U. S. A. is busily engaged in the game of obtaining *life, state and other* certificates to teach *without taking examinations.* It is refreshing, now and then, to find a place where the prospective teacher is asked *to show some of his qualifications.*

The following papers speak for themselves. They suggest certain *questions.*

463. In a shop the product has to *pass inspection* before it is approved for use by the maker. This inspection to be acceptable has to be made by someone other than the workman who made it or the department in which the work was done. Before being accepted by the user it again has to pass a receiving inspection.

What parallel exists between these facts and the present willingness of teachers to accept certificates without examinations? Does this practice apply to other professions such as lawyers, doctors, dentists, veterinaries,

accountants, etc.? Does the practice help the professional standing of the teacher?

UNIVERSITY OF TORONTO
FACULTY OF ARTS
ANNUAL EXAMINATIONS, 1925
FOURTH YEAR—SCIENCE FOR TEACHERS
PHYSICS.

Examiner—E. F. Burton

1. What is meant by double refraction?

Define the meaning of ordinary index of refraction and extraordinary index as applied to Iceland Spar.

Give the construction of a Nicol prism. Which ray emerges from a Nicol, the ordinary or the extraordinary?

2. Give the meaning (without proving) of the formula

$$\frac{I}{I_0} = \cos^2(\beta - a) - \sin 2a \sin 2\beta \sin {}^2\pi\delta.$$

noting the meanings of the various letters.

Show how this formula indicates the effect of

(a) rotating the analyser with the mica plate fixed in position,

(b) rotating the mica plate between fixed crossed Nicols.

3. How would you determine experimentally that a beam of light consisted of (a) completely plane polarized, (b) elliptically polarized light.

4. What is meant by the property of radioactivity?

How would you find whether a given mineral specimen were radioactive or not? Describe the apparatus used in this case.

If it were radioactive, how could you determine whether it contained radium or not?

5. We speak of a, b and v rays.

Differentiate between these rays with regard to

    (a) their nature or constitution,

    (b) their velocities,

    (c) their electrical charges,

    (d) the effect of a magnetic field on them,

    (e) their absorption by matter.

6. Describe a method by which the actual number of a rays given off by 1 grm. of radium per second has been determined.

What is the modern view of the constitution of an a rya?

What experimental evidence is there to support this view?

464. In what respects do you as a competent teacher of physics (or science) object to this examination paper? Pro and cons please.

Department of Education   *The City of New York*

EXAMINATION FOR LICENSE TO TEACH IN HIGH SCHOOLS
GENERAL SCIENCE

December, 1923

Time—Three hours.   Candidate's Number............

Note—Candidates are expected to give evidence in their written answers of a creditable degree of ability in the use of English. Failure to reach this standard will of itself constitute sufficient ground for rejection.

Candidates who do not meet the eligibility requirements and who nevertheless take the examination will not be permitted to enter a claim for license even if they pass the tests.

First answer questions 1 and 2, then from any one group answer all three questions, then answer any other three questions, making eight answers in all.

1. From a consideration of a New York City boy's (girl's) civic environment select the best eight topics other than those named in this paper, for development in a high school course in general science. Briefly indicate the value of each topic selected. (16)

2. Explain with the aid of a diagram the essential principles underlying the forecasting of weather conditions by the U. S. Weather Bureau. (12)

I—*Biology*

3. Describe the plant from which linen is made and give the steps in the process of preparing its fibres for commercial use. (12)

4. Give in detail with sketches the life history of the common household insect pest, the so-called "Croton Bug." (12)

5. Explain, using a diagram, the location and functions of the human sympathetic system. (12)

II—*Chemistry*

6. Explain with formulae the history of Portland cement from its origin in rock to its final use in concrete construction. (12)

7. Explain with diagrams and formulae the commercial production of sulphuric acid. (12)

8. Explain with diagrams and formulae the harmful production of carbon monoxide by a gas stove and by an anthracite furnace. (12)

III—*Physics*

9. What, in order of importance, are the most important physical obstacles to the construction and use of a dirigible? Show briefly how each has been overcome. (12)

10. By diagrams explain the paths of rays of light from a parabolic mirror (automobile headlight) and show the principle underlying the so-called safety lenses offered for sale. (12)

11. What is meant by "reflex" in radio work and of what value is it in receiving messages? (12)

465. In what respects, if any, will such an examination as the New York City examination in General Science help to pass upon the qualifications of a teacher?

What success factors are omitted? How should they de determined? Should an *intelligence* test be given?

EASY TRANSPORTATION CAUSE OF DISAPPEARING FORESTS.

America's far-flung transportation system has been one of the main causes of forest depletion, and may be turned into its principal cure, according to William B. Greeley, chief of the United States Forest Service, and chairman of the National Conference on Utilization of Forest Products.

"It is worth pointing out that the United States is the first country where the exhaustion of timber in one section could be readily met by the cutting of forests 2000 miles distant," he said. "Our transportation system has largely concealed the ultimate outcome of the exhaustion of old growth timber.

"This marvelous tool of transportation ought to be employed with equal effectiveness in carrying out the economies now forced upon us. It ought to make a local surplus of waste timber or inferior woods nationally available.

"An official of an important New England railroad recently proposed that low grades of lumber be given lower freight rates in order that the railways may get the benefit of the traffic. If this proposal is sound from the standpoint of the railroad, it is doubly sound from the standpoint of timber conservation."

Mr. Greely also re-emphasized the importance of preventable decay. "Preventable decay probably destroys enough wood annually in the United States to build a city for a million people," he said.—*Science Service.*

ARTICLES IN CURRENT PERIODICALS.

American Botanist for January. *Joliet, Illinois*, $1.50 a year, 40 cents a copy.

The White Snakeroot, Willard N. Clute.

The High-Bush Cranberry, Fannie M. Heath.

Wild Crab-Apples, Nell McMurray.

Meaning of Plant Names—XXII, Solanaceae, Willard N. Clute.

American Journal of Botany, for February, *Brooklyn Botanic Garden*, $6.00 per year, 75 cents a copy.

A Preliminary Sketch of the Plant Regions of Oregon II. The Cascade Mountains and Eastward, Morton E. Peck.

The Effect of Selenium Compounds upon Growth and Germination in Plants, Victor E. Levine.

Pruinose Branchlets and Salix Lemmonii Bebb, Carleton R. Ball and Kirk Whited.

The Occurrence of Purple Bacteria as Symbionts of a Lichen, J. C. Th. Uphof.

The Chromosome Morphology of Velthemia. Allium, and Cyrtanthus, William Randolph Taylor.

Observations on the Poisonous Plants of Michigan, E. F. Woodcock.

American Mathematical Monthly, for February, W. D. Cairns, *Oberlin, Ohio*, $5.00 a year, 60 cents a copy.

Algebra at Harvard College in 1730, Lao Genevra Simons.

On the Correlation Between Two Variates x and $y = kx^2$. Karl Pearson.

Note on the Geometric Aspects of Einstein's Theory, C. N. Reynolds.

Questions and Discussions: Replies to Question 52, Norman Anning and C. H. Chapmell. Discussions—"Note on 'Limit proofs in solid geometry'" Paul Capron; "An elementary solution of a problem of Diophantus", A. A. Bennett.

Chemical Education for February, *University of Md., College Park, Md.* $2.00 a year.

The Effects of Different Instructors for Recitation and Laboratory in Freshman Chemistry, F. E. Brown and Kenneth L. Bird.

The Orientation of the Bonds of Tervalent Nitrogen, J. A. Nieuwland.

High School Chemistry: The Student's Viewpoint, A. J. Currier.

An Experiment in Teaching, Charles H. Stone.

The Place of Analytical Chemistry in Agriculture, Henry R. Kraybill.

The Teaching of Biological Chemistry, R. Adams Dutcher.

The Standardization of Weights by Richards' Method, Waldo L. Semon.

Problem Work in Elementary General Chemistry, Stuart R. Brinkley.

Some Misconceptions of Chemical Education, Stephen G. Rich.

Condor, for January-February, Pasadena, California, $3.00 a year.

The Nest and Eggs of the Black Rosy Finch (with three photos). Frederic W. Miller.

A Seven-Year Duck Census of the Middle Rio Grande Valley (with three sets of graphs) Aldo Leopold.

Communism in the California Woodpecker (with one photo), Frank A. Leach.

A Report on the Birds of Northwestern Alaska and Regions Adjacent to Bering Strait. Part I (with six photos), Alfred M. Bailey.

White Pelicans in Nevada (with one photo), Laura Mills.

Journal of Geography, for February, 2249 *Calumet Ave., Chicago*, $2.50 a year, 35 cents a copy.

The Changing Role of the Kentucky Mountains and the Passing of the Kentucky Mountaineer, D. H. Davis.

The Scandinavian Peninsula, Frederick K. Barnom.

Geographic Principles in the Study of Cities, Douglas C. Ridgley.

Education, for February, 120 *Boylston St., Boston, Mass.*, $4.00 a year, 40 cents a copy.

Salvage of the Non-Nordic, Walter S. McNutt.

High School Commercial Subjects as Entrance Credits to Collegiate Schools of Commerce, R. G. Walters.

Please mention School Science and Mathematics when answering Advertisements.

Dwight Reasoning Test, Charles A. S. Dwight.

Shall We Employ the Direct Method in Modern Language Instruction? F. D. Cheydleur.

Photo-Era, for February, *Wolfeboro, N. H.* $2.50 a year, 25 cents a copy.

The Eye, the Camera and Focusing, Robert T. Pound.

Some Notes on Stereoscopic Color-Photography, E. V. Glanville.

The Camera in Star-Land, Part III, James Stokley.

Pictorial Advertising, N. Courtney Owen.

Practical Kinematography, Chapter III, Herbert C. McKay.

Winter Opportunities Out-of-Doors, William S. Davis.

School Review, for February, *University of Chicago Press,* $2.50 a year. 30 cents a copy.

Tests of Personality Traits, Frank N. Freeman.

Status of Summer High Schools in Cities of More Than 100,000 Population, M. David Hoffman.

Student Government, A Project Method, Ethel M. Parmenter.

Teacher Co-operation in the Administration of the High School, Thomas M. Deam.

Incentives to Higher Scholarship, Grace T. Lewis.

Five Years of the Junior High School Idea in a Small City, L. R. Creutz.

Scientific Monthly, for March, *Garrison, N. Y.* $5.00 a year, 50 cents a copy.

New Problems of Western Civilization: The Conservation Problem of the Paper and Pulp Industry, Professor Henry S. Graves; Population Problems of South America, William A. Reid; Racial Differences in Mental Ability, Dr. Bertha M. Luckey; The Comparison of Races, Reverend James E. Gregg; The Use of the Median in International Migration, Dr. Roswell H. Johnson; Modern Business Education and Research, Dr. Joseph Mayer; Employe Representation, Dr. Henry C. Metcalf; The Economic Importance of the Conservation of Vision, Dr. Michael V. Ball; Economic Aspects of Heart Disease, Dr. Robert H. Halsey.

The State of Science in 1924: Verification of the Theory of Relativity, Sir Frank Dyson; The Origins of Wireless, Sir Richard Glazebrook.

The Physical Basis of Disease, The Research Worker.

The Historical Development of Surgical Anesthesia, Professor Chauncey D. Leake.

Torreya, for January-February, *Lancaster, Pa.* $1.00 a year, 30 cents a copy.

Some Tree Buds, George T. Hastings.

Unreported Plants from Long Island, N. M. Grier.

Further Notes on Woody Plants, W. W. Ashe.

A New Whitlow-wort from Florida, John K. Small.

The English Sparrow, W. A. Murrill.

Weather Review for November, *Washington, D. C.* $1.50 a year, 15 cents a copy.

An Analysis of a Retrograde Depression in the Eastern United States of America, J. Bjerknes and M. A. Giblett, (5 figs.).

Forty Years' Study of Snow Crystals, W. A. Bentley. (36 figs.)

Variation in Solar Radiation Intensities Measured at the Surface of the Earth, H. H. Kimball. (1 fig.)

An Approach to Runoff Expectancy, S. L. Moyer. (5 figs.)

Comparison of Rainage Can and the Horton Snowboard Measurements of Snowfall at Grand Forks, N. Dak. A. W. Cook. (1 fig.)

Twilight Phenomena on Mont Blanc, E. Bauer, A. Danjon and J. Langevin.

In the United States, 1,200,000 cots live within the limt of incorporated cities.

BOOKS RECEIVED.

Studies in Secondary Education II by Wm. C. Reavus, Chairman. Pages v+202. 16.50x23.50 cm. Paper, 1925. University of Chicago Press.

Beacon Lights of Science by Theodore F. Van Wagenen. Pages xv+444. 14.50x20.50 cm. Cloth, 1924. Thomas Y. Crowell Co., Publishers, New York City.

Eye Sight Conservation, Bulletin 5 by Eye Sight Conservation Council. 95 Pages. 15x21.50 cm. Paper, 1925. Eye Sight Conservation Council, Times Building, New York City.

BOOK REVIEWS.

Lippincott's Farm Manuals by Robert H. Smith, New York State School of Agriculture, Canton, New York. Pages vii 357. 15x21 cm. Cloth, 1925. J. P. Lippincott Co., Philadelphia.

Recent development in agricultural education has emphasized the need and absolute necessity of the farmer being familiar with tools appertaining to the black-smith, carpenter, machinist, plumber and any other trade that would have anything to do with the modern up-to-date farm plant.

In fact, the farmer must now-a-days, not only be able to till the soil intelligently but must have working knowledge of all the trades just mentioned, and one of the best methods for him to secure this information is from the agricultural college.

Of course, this more particularly applies to future farmers, than to the present ones.

This text has been written for the accomplishment of this very thing. The modern farmer must know how to repair his farming implements and machines. If these things are kept in working condition, the farmer's income will be greatly enhanced. The modern farm should have a workshop sufficiently large to admit the largest machine tht the farmer may have on his place. It doesn't matter whether this be a separate building or a room set aside for the purpose in one of his barns.

This book goes into detail in a splendid way, giving hints as to how timber should be used and worked up, how to do the blacksmith's end of the game, machine shop work, too, as to how to put a hydraulic ram into condition, etc.

The diction is splendid. There are twenty chapters. Each one of which closes with a list of practical questions and exercises. There are 366 cuts and half-tones scattered through out the book, all selected for the purpose of emphasizing the thing they are to teach.

It is printed on high grade paper, which is really too highly calendered. A knowledge of the matter contained in this text will cause the farmer to add greatly to his yearly income.

All farmers should procure and study this book.   C. H. S.

Beacon Lights of Science by Theo. F. Van Wagenen. Pages xv 444. 14x20.50 cm. Cloth, 1924. Thomas Y. Crowell Co., Publishers, New York City.

This book has been written for the purpose of tracing the development of science throughout the centuries, by giving a short biographical sketch of those persons who have contributed materially to the advancement of science.

It is a general text, a book giving the high points in the career of these men who have contributed so nobly to the progress which science has made.

Those interested in the advancement of science should procure the book for their library.   C. H. S.

The Electron. by Robert A. Millikan, Norman Bridge Laboratory, Los Angeles, pages XIV plus 293, 13x19 cm.   Cloth, 1924.   The University of Chicago Press, Chicago.

This is a book which records the history of our acquisition of knowledge of the molecular atomic and electronic worlds as well as of radiant energy, which explains the present and the recent in the light of the more distant past.   The worker in this field will find it of the greatest service in clarifying and relating the recent advances and discoveries of physics. The layman who is already interested in such matters, or who has a healthy curiosity, will find the treatment not too technical.   He may omit the mathematical formulae, and the details of experiments, when these get beyond his comprehension, without impairing his ability to appreciate and to understand the conclusions proved or the theories stated. The edition of 1924 contains the last word in both these particulars.

On every page is apparent the author's ability to explain briefly and clearly, to see things in the proper perspective, to speak with modesty of his own achievements, great as they are, and to give full credit to others for their contributions in this field.   We also see, the author's open-mindedness, his reverence for truth and for the God of truth back of the physical phenomena.   We see the dry humor of the man when he suggests that to count the electrons contained in the quantity of electricity coursing every second through a 16 candle-power filament, it would take the 3,000,000 inhabitants of Chicago twenty thousand years, each counting at the rate of two a second, provided no one ever stopped "to eat, sleep or die."   We are left with a clear appreciation of the advances of the past, especially of the last twenty-five years, and with an equally clear appreciation of the great problem of the future, the relation of the atomic and electronic worlds to the world of ether waves.

A. W. SMALLEY.

Chemistry in Industry.   A cooperative work intended to give examples of the contributions made to industry by chemistry.   Edited by H. E. Howe, Chairman, American Chem. So. Committee on Prize Essays, Editor, Industrial and Engineering Chemistry.   1st edition.   XII plus 372 pp.   14.5x21x3.3 Cm.   Cloth, 1924.   Special price, $1 per copy postpaid from the Committee on prize essays, 85 Beaver St., New York.   Make checks payable to Alexander Williams, Jr., Secretary.

"The various relations of chemistry to the industrial life of the United States are treated authoritatively by scientific men in nontechnical language and in a manner that will grip the general reader."

Every school library should take advantage of this gift offer and procure a copy of this book.   The writers are picked men who are experts in their respective fields but somehow Howe has charmed them into using the language of the man in the street in dealing with their subjects.   The first chapter is by Robert E. Rose, Director of the Technical Laboratory, E. I. du Pont de Nemours & Co.   Mr. Rose deals with The Foundations of Chemical Industry giving an extremely readable account of the making of the fundamental heavy chemicals sulphuric and nitric acid, caustic soda, washing soda, and baking soda.

F. J. Tone, President, The Carborundum Co., writes of Abrasives, with especial reference to the artifical abrasives such as carborundum and the aluminum oxide products.

Alcohol and some other solvents is written by D. B. Keyes, Research Lab., U. S. Industrial Alcohol Co.

Coal, coke and their products is the topic of F. W. Sperr, Jr., Chief Chemist, The Koppers Co.

Back numbers of School Science, School Mathematics, and School Science and Mathematics may be had for 30 cents a single copy. The Mathematical Supplements for 15 cents a copy.

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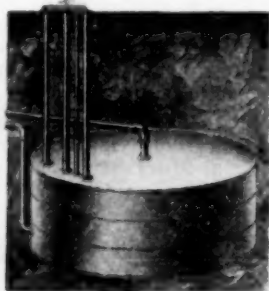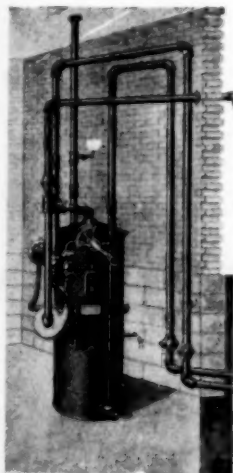
Thomas C. Law, President Law & Co., Inc., writes of Cotton and Cotton Products.

Chemistry in the Electrical Industry is written by Buckner Speed, Technical Expert, Western Electric Co.

Some Applications of Electrochemistry is the subject of A. H. Hooker, Technical Director, Hooker Electrochemical Co.

R. B. Deemer, Assistant Biochemist, Bureau of Plant Industry, U. S. Dept. of Agriculture, deals with Chemistry in the Fertilizer Industry.

Industrial Gases is the title of the chapter by Clark S. Robinson, Dept. of Chem. Engineering, Mass. Inst. of Technology.

Glass, One of Man's Blessings, is by Alexander Silverman, Head, Dept. of Chemistry, Univ. of Pittsburgh.

A. E. White, Director of the Department of Engineering Research, University of Michigan, has contributed a chapter on The Elements of Iron and Steel Manufacture.

John Arthur Wilson tells much of interest concerning The Making of Leather. Mr. Wilson is the Chief Chemist of the A. F. Gallun & Sons Company.

Nonferrous Metallurgy is the subject dealt with by H. W. Gillett, Chief Division of Metallurgy, Bureau of Standards.

Maximilian A. Krimmel of the Hammermill Paper Company is the author of the chapter on Chemistry in the Pulp and Paper Industry.

Perfumes and Flavors is an interesting subject and is treated exceptionally well by S. Isermann, President, Van Dyk & Company and the Chemical Company of America.

The Petroleum Industry, by Gerald L. Wendt, Assistant Director of Research, Standard Oil Company (Indiana), gives one a good idea of the chemistry of that industry.

S. E. Sheppard, Assistant Director, Research Laboratory, Eastman Kodak Company, deals with an interesting field of chemistry in his chapter on Photography, or Picture Making by Light.

Synthetic Resin: A Chemical Contribution to Structural Materials is the contribution of A. V. Mory, Assistant Director, of Research, Bakelite Corporation.

W. J. Kelley, Research Laboratories, Goodyear Tire & Rubber Company writes on Chemistry in the Rubber Industry.

The last chapter is on Chemistry in the Textile Industry by L. A. Olney, Professor of Chemistry and Dying, Lowell Textile School; President, Stirling Mills and American Association of Textile Chemists and Colorists.

The above list speaks for itself.　　　　　　　　　　　　　F. B. W.

Fifty Famous Farmers, by Lester S. Ivins, Kent State Teachers College, Kent, Ohio, and A. E. Winship, Lecturer and Editor. Cloth, 407 pages, 13x20 cm., illustrated. The Macmillan Company, 1924 (Dec.)

This is a timely book which we were glad to see. The authors truly say in the preface that "adults as well as children too often get the idea that great men are made rather as the result of wars and other *destructive* agencies than by the *constructive* agencies such as agriculture." The accounts of the lives of these fifty great farmers have been arranged in such a way as to tell a story of the history and development of agriculture. Thus we find one group of "Farmer Inventors" and another of "Creators of Better Plants and Animals"; others of "Soil Experts"; "Leaders in Rural Economics and Social Life" and "Administrators of Agriculture." It is a notable list of men of which any country might well be proud. The authors have done a good service.

W. W.
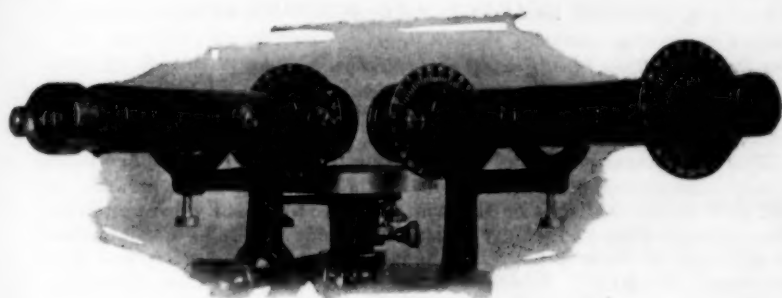
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The Botany of Crop Plants, a text and reference book by Wilfred W. Robbins, University of California, Second Edition. Cloth, XVI plus 673 pages, 13x19 cm. with 263 illustrations. 1924. $2.00. P. Blakiston's Son & Co., Philadelphia.

This is a revised edition of a very valuable book. The author has not changed the general plan of the book, but has made use of new information and more recent statistics on the crop plants to bring the work up to date. There is a growing and wholly desirable tendency among botany teachers to make use of the crop plants in the laboratory for illustrative and study purposes. Why not? Familiar plants have certain distinct advantages as laboratory material well worth utilizing.

For those who are not familiar with this book we may add that it contains a great fund of organized information about the crop plants. It is beautifully and very fully illustrated. The book should be in the library of every teacher of botany and agriculture. W. W.

Methods in Plant Histology, by Charles J. Chamberlain, Ph. D., Sc. D., Professor of Morphology and Cytology, University of Chicago. Fourth revised edition. XI plus 349 pages, cloth, 14x21 cm. 117 illustrations. 1924. Cost $3.25. The University of Chicago Press.

Methods in Plant Histology is a well-known and standard treatise on the laboratory technique of plant study. Professor Chamberlain has been using and perfecting methods of laboratory technique for many years and this book represents the results of these years of his study together with the assistance of many co-workers. The book is indispensab'e to any serious study of plants. It is inclusive in its field and thoroughly up to date. W. W.

IMPORTANT WORK BY CHICAGO EVENING SCHOOLS.

Chicago's public evening schools enrolled more than 50,000 persons in the past school year. These schools offer courses divided into six groups: English for the foreign-born; elementary-school subjects, high-school subjects, home economics, commercial subjects, and industrial subjects. The most popular classes were those for the foreign-born, which enrolled 11,791 persons, more than one-third of them women. Commercial classes enrolled the next greatest number, 10,260. More than half the students in the commercial group were women, most of whom studied stenography and typewriting. The home economics courses, which included cooking, plain sewing, trade dress-making, and trade millinery, were attended by nearly 6,000 women.

About 9,000 men and 300 women were registered in the industrial courses. Automobile engineering was the most popular of the industrial subjects, enrolling 2,520 men and 36 women. Mechanical drawing and electricity attracted more than 1,000 students each. Other well-attended courses were machine-shop work, woodworking, applied chemistry, and printing.

High-school courses enrolled nearly 10,000 students, English standing first among the subjects taught with 2,812 students, physical education second, with 2,289, and mathematics third, with 1,611. Beside academic subjects and physical education, the high-school courses included such subjects as vocal music, orchestra, radio, journalism, commercial art, and dramatics. Work done in the evening high school is credited toward a high school diploma. Altogether, 52,682 students attended the evening courses, more than half of them men. *Bureau of Education.*

CONTENTS *for* MAY, 1925

No Numbers Published for
JULY, AUGUST AND SEPTEMBER